HENRY MINE

REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

REMEDIAL INVESTIGATION REPORT

FINAL - REVISION 2

Henry Mine

P_4 PRODUCTION, LLC

OCTOBER 2017

Prepared by:

MWH Americas, Inc.

EXECUTIVE SUMMARY

ES.1 PURPOSE OF REMEDIAL INVESTIGATION AND RISK ASSESSMENT

This Executive Summary presents a brief overview of the scope and findings of the Remedial Investigation (RI) performed by P4 Production, LLC (P4) at the Henry Mine and surrounding area. The RI was performed to meet the requirements of the 2009 Administrative Settlement Agreement and Order on Consent/Consent Order (2009 CO/AOC*)* for the Remedial Investigation/Feasibility Study (RI/FS) with the USEPA and other agencies and the Tribes (A/Ts) listed in the main body of this *RI Report*. The 2009 CO/AOC is inclusive of the three P4 Sites - Ballard, Henry, and Enoch Valley Mines and specifies that individual RI and FS documents will be prepared for each of these Sites.

As identified in the *Ballard, Henry, and Enoch Valley Mines RI/FS Work Plan Final Revision 2 (MWH, 2011)*, the RI and FS for the P4 Sites should focus on the potential for exposure to upland soil, upland and riparian vegetation, riparian soil and sediment, surface water, groundwater, and biota with elevated contaminants or radionuclides of concern (COCs) and contaminants of ecological or livestock concern (COECs). The RI scope is limited to the Henry Mine and the area surrounding the Henry Mine that could be affected by the mining operation (referred to as the Henry Site or Site). This includes the physical Henry Mine area and nearby private, State and BLM-owned lands in generally downstream/downgradient directions.

The purpose of the RI in this process is to gather relevant data for characterization of the Site using the guidance for conducting RI/FS (USEPA, 1988), and the purpose of this *RI Report* is to summarize those data that have been collected during the Site investigations. Therefore, this *RI Report* includes the results of field activities and characterizes the sources of contamination, nature and extent of contamination, and the fate and transport of constituents detected for the Site. Data collected during the RI (2009 to 2014) and prior to the RI (2004 to 2008) during the previous Engineering Evaluation/Cost Analysis (EE/CA) Site Investigation (SI) are included and utilized in this *RI Report*.

Also included as an appendix to this RI Report is the baseline risk assessment (BRA) which evaluates and determines the incremental risks above background to an agreed upon list of human, ecological and livestock receptors and pathways at the Site. The RI and BRA findings are discussed below.

ES.2 HISTORY OF MINE OPERATION

The Henry Mine is the second oldest of the three phosphate mines being addressed in the P4 Sites RI/FS and was mined from 1969 to 1989. Monsanto (P4) leased the mineral rights from the BLM for Henry Mine by way of two leases issued in 1960 and 1965. P4 records indicate that 99.6 million cubic yards (MCY) of waste rock was moved from five pits at the Henry Mine. The estimated volume in the external waste rock dumps is 32.3 million cubic yards (MCY). Therefore, 67.3 MCY are estimated to be contained in the mine pits as backfill. Monsanto relinquished both of the Henry Mine mineral leases to the BLM in 1993 following reclamation.

The Henry Mine was transitional between historical and more modern reclamation practices. Most of the mine pits (except for northern and southern ends) have been backfilled, graded to promote stormwater drainage away from the pit backfill, and were covered and seeded to prevent erosion and provide controlled grazing. Small sections of the mine highwalls remain exposed in the pit areas. General practices at the Henry Mine included the use of oxidized brown shale (weathered shale of the Meade Peak Member) as a cover over various waste rock materials as outlined in the approved mine reclamation plans (Monsanto, 1981). All of the mine waste rock areas were successfully regraded and revegetated with generally excellent vegetation quality and coverage.

ES.3 REGULATORY AND INVESTIGATION HISTORY

Investigations to assess potential impacts of phosphate mining in southeastern (SE) Idaho on human health and the environment increased in 1996 after several horses were diagnosed with selenosis and subsequently euthanized. From 1997 to 2001, the Idaho Mining Association (IMA) voluntarily conducted a regional investigation with the A/Ts being afforded the opportunity to review and comment on all plans and reports. The Idaho Department of Environmental Quality (IDEQ) took over as project lead in 2001, with the IMA participating companies, including P4, signing an area-wide consent order (2001 CO/AOC). In 2003, P4 entered into a mine-specific CO/AOC (2003 CO/AOC) for the Ballard, Henry, and Enoch Valley Mines to conduct an EE/CA (USEPA, 2003). All P4 Sites investigation work undertaken in 2004 and since then has been, and continues to be, performed under the direct oversight and approval of the A/Ts. With the implementation of the 2009 CO/AOC, the EE/CA was transitioned to the RI/FS and the USEPA became the lead agency.

ES.4 PRINCIPAL INVESTIGATIONS AND RI/BRA FINDINGS

Over the years, P4 performed extensive sampling and analyses of various media including:

- Upland Soil – 125 locations were sampled for upland soil in 2004, 2009 and 2014.
- Upland Vegetation – 202 locations were sampled for upland vegetation during investigations in 2004 and 2009.
- Riparian Vegetation – 28 samples were collected for riparian vegetation during a 2004 investigation.
- Riparian Soil – 33 samples near the Site water ways were sampled for riparian soil between investigations conducted in 2004 and 2010.
- Sediment – 27 locations were sampled for sediment between investigations conducted in 2004 and 2010.
- Surface Water – 127 surface water samples were collected during 17 events between 2004 and 2014.
- Groundwater – 92 groundwater samples (which includes 17 temporary direct-push boreholes) were sampled during 17 events between 2004 and 2014.

The following subsections present a summary of the principal findings for the RI program and the BRA that was prepared using the RI data.

ES4.1 Nature and Extent of Contamination

As described in Sections 4.0 and 5.0 of this *RI Report*, the findings provide sufficient information to characterize the nature and extent of constituents associated with various media including the source materials (i.e., mine waste rock) at the Site. The nature and extent of contaminants associated with the Site were identified through review of historical information that confirmed characteristics of the mined materials and mining practices, and extensive sampling of the various media within and downslope of the Site.

The widely recognized source material of contaminants associated with phosphate mining in SE Idaho is the Meade Peak Member of the Phosphoria Formation. In particular, the waste shale between ore horizons contributes much of the constituent loading. This is in part because the middle, or center waste shale (CWS) as it is known, represents a significant portion of the waste rock that is stockpiled in waste rock dumps when the ore is removed, and this shale is enriched with constituents including selenium. In general, constituents are leached from the waste rock in mine dumps through precipitation contact with the waste rock, which either directly runs off as surface water, mostly during the spring snow melt, or infiltrates into the mine dump and appears as contaminated seeps at the toe of the piles. Depending on Site conditions, water can continue downward through the mine dumps and infiltrate into the underlying shallow groundwater. This water then will be present either as seeps or springs further downslope, or as shallow alluvial groundwater plumes downgradient of the mine waste rock source areas.

At the Henry Site, groundwater contamination in bedrock appears to be limited to an area immediately adjacent to the waste rock dump in the Dinwoody Formation. Sediment and surface water in the stream channels leading from the waste rock dumps contain some elevated constituents, which rapidly decrease in the downstream direction and are most elevated in the on-Site pond locations. Similarly, riparian soil and riparian vegetation contain constituents, which are most elevated near the reclaimed dumps and on-Site pond locations, but rapidly decrease in a downstream direction. Upland soil samples, collected primarily from the soils developed on the graded and reclaimed the waste rock dumps, are comprised in many cases of brown shale that contain elevated constituents (as does the vegetation that grows upon the reclaimed areas). In summary, the areal distribution of constituents is limited to the waste rock dumps and backfilled pits that have been reclaimed throughout the Site. Contamination is transported relatively short distances downstream or downgradient of the reclaimed waste rock dumps/backfilled pits by surface water and groundwater that have elevated constituents due to contact with waste rock. However, downstream transport of constituents to significant surface water streams (e.g., the Little Blackfoot River) or potential groundwater supply sources is not occurring.

ES4.2 Summary of Human Health Risks

A human health risk assessment (HHRA) was performed using conservative assumptions to evaluate risks posed to current and potential future human receptors exposed to detected Site constituents. **Tables 7-1** and **7-2** list the nature and extent of contamination by medium and identify the affected human receptors and COCs posing potential risks to those receptors. Under hypothetical future use conditions, certain scenarios are associated with predicted human health risks greater than regulatory risk criteria – that is, an incremental cancer risk of $1x10^{-5}$ (IDEQ) or a cancer risk management range of $1x10^{-6}$ to 1×10^{-4} (USEPA) or an incremental hazard index (HI) greater than 1. Based on results of the HHRA, constituents contributing most to predicted hypothetical future use risks in excess of these criteria are: arsenic, cadmium, selenium, thallium, and uranium as noted in **Tables 7-1** and **7-2**.

Currently, reclaimed portions of the Site are used for grazing. This includes former P4-leased BLM and State lands along with privately-held P4 lands. Recreational activities such as hunting currently may occur on former P4-leased State and BLM lands, but is only possible by accessing these areas on foot, as P4 maintains fences and locked gates around the mine property. Recreational activities are not permitted on P4-owned portions of the Site.

It should be noted that future Site uses will continue to emphasize grazing on reclaimed State/BLM lands, along with some recreational activities (such as hunting, camping and hiking). Grazing also is the most likely future land use for the reclaimed P4-owned areas of the Site. It is unlikely that recreational use by the public would be permitted by P4 in the future on their privately-held portions of the Site, nor would subsistence or residential land uses be allowed.

Cumulative, combined media, total and incremental cancer risk estimates for the recreational hunter and camper/hiker receptors exceed the IDEQ cancer risk criterion but are within USEPA's cancer risk management range. Cumulative, combined media, incremental HIs for these receptors are below 1. These upper-bound cancer risk and HI estimates are based on conservative assumptions and, as such, these receptors are not likely to be adversely affected by the Site. Recreational fishing also was evaluated along the Little Blackfoot River, which passes through the Site, because it is the only stream on Site that is perennial and contains fish. Incremental combined media cancer risk and noncancer HI estimates for the recreational fisher are below IDEQ and USEPA cancer risk and noncancer HI criteria. Consequently, this receptor land use has not been adversely impacted by the detected Site constituents.

The incremental combined-media cancer risk and noncancer HI estimates for the seasonal rancher also exceed IDEQ cancer risk and noncancer HI criteria, and the USEPA's cancer risk management range and HI of 1. However, the background cancer risk estimates for this receptor also exceed IDEQ risk criteria and the USEPA's risk management range. It should be noted that the seasonal rancher scenario assumes that seasonal ranchers live on the reclaimed Site areas during the portion of the year that their cattle graze on-Site. This assumption assumes daily direct contact exposure to soil and consumption of groundwater as a potable supply during the grazing period. In actual practice, however, seasonal ranchers don't reside on the Site, nor are they likely to reside there in the future; rather, they visit the Site occasionally during the grazing season to check up on, and tend to their cattle. Additionally, it is highly unlikely that a seasonal rancher would install a potable supply well on former P4-leased BLM and State lands or privately-held P4 lands. Currently, and likely in the future, the rancher brings drinking water from off-Site during the occasional Site visits. Based on the above, it is highly unlikely that current and anticipated future grazing on reclaimed portions of the Site is adversely affecting the health of seasonal ranchers.

The Native American and hypothetical future resident were evaluated to determine if land use controls and/or remediation are required to protect potential future subsistence or residential land uses for the Site. Although such land uses are unlikely to occur in the future on the actual mine surface area. Incremental cancer risk and noncancer HI estimates for the Native American, hypothetical future resident, and seasonal rancher are greater than $1x10^{-4}$ and 1, respectively. Therefore, further evaluations in the FS of area-specific remedial alternatives, including institutional land use controls, will be required to protect these potential receptors/land uses on the Henry Mine, proper. Because the contaminant concentrations associated with excess risk for these receptors decrease rapidly downslope from the mine dumps, it is anticipated that current or potential future subsistence or residential land uses off the current reclaimed mine dumps would not be adversely impacted.

ES4.3 Summary of Ecological Risks

An ecological risk assessment (ERA) was performed using conservative assumptions to bound risks for a select group of ecological receptors that include mammalian and avian species that are presumably present at the Site and could be exposed to contaminants found in the Site media. No Observed Adverse Effect Level (NOAEL)-based Tier II hazard quotient (HQ) estimates in excess of 1 are calculated for the several mammalian and avian receptors. **Table 7-4** shows the range of Site-wide HQs for ecological receptors with HQs exceeding the USEPA's and IDEQ's acceptable HQ of 1. NOAEL-based Tier II HQ estimates in excess of 1 are calculated for the following receptors: long-tailed vole, deer mouse, raccoon, mink, coyote, American goldfinch, American robin, mallard duck, great blue heron and northern harrier exposed to Site media. Analytes with NOAEL-based Tier II HQ estimates in excess of 1 include: aluminum, antimony, cadmium, chromium, copper, molybdenum, nickel, selenium, thallium, vanadium and zinc. With the exception of antimony and thallium, for which Site ecological hazards are less than background ecological hazards, these analytes are listed as preliminary COECs.

These ecological risks estimates represent upper bound estimates that may "overestimate" Site risks. As shown in **Table 7-4**, the background HQs are in excess of 1 for all mammalian receptors that were evaluated and for two of the five avian receptors that were evaluated (exceptions include the mallard duck, great blue heron, and northern harrier).

ES4.4 Summary of Livestock Risks

A livestock risk assessment (LRA) was performed to evaluate potential impacts of Site contaminants on grazing animals. Beef cattle were selected as the livestock indicator receptor. Although sheep may selectively forage on selenium hyperaccumulator plant species and episodes of mortality in sheep foraging on mine sites in the area, including the Henry Mine, are well documented, beef cattle are more susceptible to selenium toxicity than sheep. Therefore, sheep were not quantitatively evaluated in the LRA.

NOAEL-based Tier II HQ estimates for beef cattle exposed to soil, upland vegetation, and surface water at the Site and background locations are below 1 (**Table 7-4**) for all constituents of potential concern and, therefore, no adverse effects to livestock are anticipated. These hazard estimates are consistent with results of the 1999/2000 Henry Mine cattle grazing study, which showed no adverse effects to cattle grazing on reclaimed mine waste rock dumps.

ES4.5 Information to Support the FS

The information presented in this *RI Report* indicates that the nature and extent of contamination associated with source materials and downstream/downgradient media for the majority of the Site have been bound and the risks posed to human health and the environment are sufficiently understood to allow the CERCLA process to proceed to the FS.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES continued

(Section 6.0 Figures at end of Section 6.0 text)

LIST OF TABLES

LIST OF TABLES continued

LIST OF TABLES continued

LIST OF DRAWINGS

LIST OF DRAWINGS continued

LIST OF APPENDICES

ACRONYOMS AND ABBREVIATIONS

°C	degrees Centigrade
ºF	degrees Fahrenheit
μS/cm	microsiemens per centimeter
amsl	above mean sea level
A/Ts	Agencies and Tribes
bgs	below ground surface
BH	direct-push borehole
BLM	Bureau of Land Management (Department of Interior)
BRA	Baseline Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
cm	centimeter
cpm	counts per minute
CO/AOC	Consent Order/Administrative Order on Consent
COC	contaminant of concern
COEC	contaminant of ecological concern
COPC	constituent of potential concern
COPEC	constituent of potential ecological concern
CSM	conceptual site model
CTE	central tendency exposure
CWS	center waste shale
DAR	Data Approval Request
DO	dissolved oxygen
DQUR	Data Quality and Usability Report
DSR	Data Summary Report
dw	dry weight
e.g.	*exempli gratia* (Latin, for example)
EE/CA	Engineering Evaluation and Cost Analysis
EIS	Environmental Impact Statement
EPC	exposure point concentrations
ERA	Ecological Risk Assessment
FS	Feasibility Study
ft	feet
gpm	gallons per minute
HHERA	Human Health and Ecological Risk Assessment
HHRA	Human Health Risk Assessment
HI	hazard indices
HQ	hazard quotients
i.e.	*id est* (Latin, that is to say; in other words)
IDEQ	Idaho Department of Environmental Quality

ILCRs	incremental lifetime cancer risks
IMA	Idaho Mining Association
in	inch
LOAEL	lowest observed adverse effect level
LMS	linearized multistage model
LRA	livestock risk assessment
LCOPC	livestock chemicals of potential concern
MBW	Monsanto borehole well
MCL	maximum contaminant level, Federal drinking water standard
MCY	million cubic yards
MDL	method detection limit
MDS	Monsanto dump seep sampling location
mg/kg	milligrams per kilograms
mg/L	milligram per liter
ml/min	milliliter per minute
MMP	Monsanto mine pit
MMW	Monsanto monitoring well
MSG	Monsanto spring sampling location
MST	Monsanto stream sampling location
mV	millivolts
MWD	Monsanto waste rock dump
MWH	MWH, Inc. (formerly Montgomery Watson Harza, Inc.)
NOAEL	no observed adverse effect level
NTU	nephelometric turbidity units
ORP	oxidation reduction potential
P4	P4 Production L.L.C.
P4 Sites	Collectively the Ballard, Henry and Enoch Valley Mines as in the 2009 RI/FS AOC
pCi/g	picoCuries per gram
pCi/l	picoCuries per liter
pCi/m^2-s	picoCuries per square meter second
RBS	rapid bioassessment score
RI	Remedial Investigation
RI/FS	Remedial Investigation and Feasibility Study
RME	reasonable maximum exposure
RPD	relative percent difference
SI	Site Investigation (component of the EE/CA)
SOW	Statement of Work (from the RI/FS AOC unless specified otherwise)
SPLP	synthetic precipitation leaching procedure
SUF	site utilization factor
TDS	total dissolved solids
TRV	toxicity reference values

Tribes	Shoshone-Bannock Tribes
UCL	upper confidence limit
UF	uncertainty factors
USEPA	United States Environmental Protection Agency
USFS	United States Department of Agriculture, Forest Service
USFWS	Fish and Wildlife Service
USGS	United States Geological Survey

1.0 INTRODUCTION

This *Henry Mine Remedial Investigation Report* (*RI Report*) has been prepared in accordance with the requirements of the Administrative Settlement Agreement and Order on Consent/Consent Order for Remedial Investigation/Feasibility Study (2009 CO/AOC; USEPA, 2009). The 2009 CO/AOC is a voluntary agreement between P4 Production, LLC (P4), a wholly owned subsidiary of Monsanto Corporation, and the United States Environmental Protection Agency (USEPA), the Idaho Department of Environmental Quality (IDEQ), the United States Department of Agriculture, United States Forest Service (USFS), the United States Department of the Interior, United States Bureau of Land Management (BLM), and the Shoshone-Bannock Tribes (Tribes). Collectively, the cooperating agencies are referred to as the Agencies and Tribes or A/Ts. The general objective of the 2009 CO/AOC was to conduct a Remedial Investigation and Feasibility Study (RI/FS) of P4's legacy mine sites, which includes the Henry Mine and surrounding area (the Site or Henry Site) as explained below. The RI/FS is being conducted in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and the associated regulations of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

This *RI Report* documents the comprehensive mine-specific RI that was conducted at the Site per the approved *Remedial Investigation/Feasibility Study Work Plan for P4's Ballard, Henry and Enoch Valley Mines* (*RI/FS Work Plan*; MWH 2011). The other two mines located to the south and northeast of Henry Site are the Ballard and Enoch Valley Sites, respectively. The sites were mined for their phosphate ore between 1951 and 2003 and are located approximately 13 to 19 miles north-northeast of the City of Soda Springs in southeastern Idaho, as shown on **Drawing 1-1**. From 1952 until 1997, mining at the P4 Sites was conducted by the Monsanto Company (Monsanto). In September 1997, Monsanto spun off its traditional chemical business to form Solutia. Monsanto and Solutia formed a joint venture, P4 Production, LLC (P4), which owned and operated the phosphate mines. P4 was assigned the phosphate mining leases and mineral rights. In May 2001, the joint venture was dissolved and P4 became a wholly-owned subsidiary of Monsanto. P4 is a current and former lease holder of State and Federal surface and mineral rights, and currently owns portions of the Sites.

The Henry Site and surrounding area is located on private, State, and Federal lands (**Drawing 1-2**). Note that the Henry Site includes both the mine features such as mine pits and waste rock dumps and includes areas where contaminants are located including off-mine surface water or groundwater. References in this *RI Report* to the Henry Mine are generally only relevant to the physical mine features and the land where P4 conducted mining or mining-related activities. Therefore, the Henry Site encompasses both the "Henry Mine" and any surrounding impacted areas.

The general objectives of the RI, as described in the 2009 CO/AOC Scope of Work (SOW) and *RI/FS Work Plan*, are to determine the nature and extent of contamination and any threat to public health, welfare, or the environment caused by the release, or threatened release, of hazardous substances, pollutants, or contaminants at or from the Sites. The purpose of this *RI Report* is to summarize the relevant data collected to characterize the Site using the guidance for conducting RI/FS (USEPA, 1988). This *RI Report* then summarizes the results of field activities that characterize the Site sources of contamination, nature and extent of contamination, the fate and transport of contaminants, and hazards associated with the contaminants.

To completely identify the hazards associated with contaminants detected at the Site, P4 conducted a three-part Baseline Risk Assessment (BRA) comprised of, (1) a Human Health Risk Assessment (HHRA), (2) an Ecological Risk Assessment (ERA), and (3) a Livestock Risk Assessment (LRA). The BRA assesses the potential human health and ecological risks posed by the Site's contaminants in the absence of any remedial action. The BRA is summarized in Section 6.0 and presented in **Appendix A** to this document.

1.1 REPORT ORGANIZATION

This *RI Report* generally follows the suggested outline in *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final* (USEPA, 1988) and consists of eight sections and four appendices, as described below:

Section 1.0 Introduction – Describes the Site background and regulatory framework.

Section 2.0 Physical Characteristics of the Study Area – Provides descriptions of the mine facilities and operations, and describes the physical characteristics of the Site and surrounding area.

Section 3.0 Site Area Investigations – Summarizes the specific studies and resulting data that are being used to characterize the Site.

Section 4.0 Nature and Extent of Contamination – Describes the type (nature) and extent of contamination within individual media associated with the Site.

Section 5.0 Contaminant Fate and Transport – Evaluates and describes the routes of potential contaminant migration, contaminant persistence in the migration pathway, and if migration is currently observed.

Section 6.0 Baseline Risk Assessment Summary – Summarizes the HHRA, ERA, and LRA contained in **Appendix A**.

Section 7.0 Summary and Conclusions – Summarizes the preceding sections and presents conclusions based on results of the investigations and the risk assessments.

Section 8.0 References

Appendix A Baseline Risk Assessment – Includes the complete HHRA, ERA, and LRA.

Appendix B Remedial Investigation Data – Provides comprehensive data tables of chemical results compared to relevant screening criteria for all Site media.

Appendix C Photographic Log of Surface Water Sample Locations – this provides a visual record of the surface water sampling locations in and around the Site.

Appendix D Comments and Comment Responses – To be added – will contain A/T comments on draft versions of this *RI Report* and P4's comment responses.

1.2 SITE BACKGROUND

This section provides a basic Site description and the operational and regulatory history. A more detailed description of the physical conditions of the Site is presented in Section 2.0. Additional details regarding the history of environmental investigations is presented in Section 3.0.

1.2.1 Site Description

The Henry Mine is located approximately 15 miles north-northeast of Soda Springs, Idaho in Caribou County within T6S, R42-43E (**Drawing 1-1**). The northern end of the mine is approximately one mile to the southeast of the small village of Henry, Idaho. The mine is accessed from Soda Springs via State Highway 34 to the Blackfoot River Road and then, with permission, the private P4 Enoch Valley haul road. Alternatively, the mine can be accessed from Highway 34 by way of the Henry Cutoff Road and then the Long Valley Road. The Site includes those areas where soil, sediment, surface water, and groundwater have been affected by the former mining activities. As presented in this *RI Report*, the extent of mine-related contamination generally coincides with the Henry Mine boundary with the exception of the area downstream of the southern end of the mine along Lone Pine Creek.

The Henry Mine has five waste rock dumps, and four mine pits (backfilled and open). These features account for 969 acres, and the total mine disturbed area, including miscellaneously disturbed ground, is approximately 1,000 acres. The mine area generally is linear in a northwest-southeast direction and is approximately five miles long, with an average width of approximately one-half mile. The configuration of the mine pits and waste rock dump areas at the mine is shown on **Drawing 1-2**.

The surface ownership of the mineral lease area includes: 689 acres owned by P4, 80 acres administered by the BLM, and 1,080 acres administered by the Idaho Department of Lands (IDL). Monsanto leased the mineral rights from the BLM for Henry Mine by way of Lease # I-011451 issued in 1960 and Lease #I-013814 issued in 1965. Approximately 680 of the 1,000 acres that was originally disturbed have been reclaimed as described below in Section 1.3.2. The remaining un-reclaimed areas include mine pits, high walls, and portions of a haul road. No ancillary facilities remain at the mine with the exception of the remnants of a partially paved haul road and various unimproved soft surface two-track roads. Portions of the mine have been used for livestock grazing since about the time the mining leases were relinquished in 1993.

1.2.2 Henry Mining and Reclamation History

Monsanto began mine operations in 1969 following several years of exploration. Mining was completed in 1989 with the BLM accepting relinquishment of the leases on December 7, 1993 following reclamation. The mining plan called for five mine panels or pits along five miles of phosphate outcrop. The mining started near the center, and then progressed outward to the southeast and northwest along the outcrop of the Meade Peak Member of the Phosphoria Formation. The initial mining was conducted in Pits I and II (MMP042 and MMP043[1]). Mining operations in the South Henry Continuation (Pit III, MMP044) started in the fall of 1976 and were completed in 1980, and mining at the Center Henry Continuation (Pit IV, part of MMP042) occurred immediately thereafter and was completed in the fall of 1985. The mining operations in the final North Henry Continuation (Pit V, part of MMP041) started at the beginning of 1986 and were completed in mid-October, 1989 (Lee, 2001).

The initial mining operation at the Henry Mine utilized scrapers for both mining and stripping waste rock and overburden. In 1986, the operation was converted to haul truck and shovel (Lee, 2001).

---

[1] MMP is the designation for Monsanto Mine Pit; MWD is the designation for Monsanto Waste (Rock) Dump. The numbering component was assigned during the Idaho Mining Association's (IMA) regional and area-wide investigation as discussed in Section 1.3.3 below. Many surface water monitoring stations (MST – streams and rivers, MDS – dump seeps, MSG – springs, and MSP – ponds) were also selected and designated during the regional investigations. Most monitoring wells (MMW), production wells (MPW), domestic wells (MDW), and agricultural wells were identified or constructed during the mine-specific investigation phase.

The five miles of phosphate outcrop developed and mined were hauled to P4's elemental phosphorus plant in Soda Springs (Lee, 2001). P4 contracted with Dravo-Soda Springs (renamed Degerstrom Ventures in 2001) for mining and ore hauling. Shipping the ore from the mine to the elemental phosphorus plant at Soda Springs was by truck with two or three belly-dump trailers similar to current haulage from P4's operating mines.

The Henry Mine was transitional between historical and more modern reclamation practices. Initially, the waste rock disposal practice was similar to that used at the Ballard Mine, with external waste rock dumps adjacent to the mine pits. However, as a result of some of the early reclamation research performed at the Ballard Mine, together with the influence of the Idaho Mine Reclamation Act of 1971, reclamation became a standard part of the mining practice at the Henry Mine. By 1978, backfilling mine pits also became a common practice. As a result, most of the mine pits have been backfilled, graded to promote storm water drainage away from the backfilled mine pits and into intermittent drainages located down slope, then covered and seeded to prevent erosion. Small sections of the mine highwalls remain exposed in many of the pit areas. General practices at the Henry Mine included the use of oxidized brown shale as a cover over various waste rock materials as instructed in the approved mine and reclamation plans that were followed during the phases of the mining at the Henry Mine (Monsanto, 1981). The oxidized brown shale is weathered shale of Meade Peak Member including the ore sequence that was unsuitable for processing. All of the mine waste rock areas were successfully regraded and revegetated with generally excellent vegetation quality and coverage.

1.2.3 Regulatory History

Investigations to assess potential impacts of phosphate mining in SE Idaho on human health and the environment increased in 1996 after several horses were diagnosed with selenosis and subsequently euthanized. Overburden and waste rock, which are byproducts of extracting phosphate ore from the earth, have the potential to release selenium to the environment at levels that exceed background levels.

During the early years of investigation (primarily 1997 – 2001), the majority of the regional investigations were conducted under direction of the Idaho Mining Association's (IMA's) Selenium Committee. Regulatory agencies provided input and some oversight through the Interagency/Phosphate Industry Selenium Working Group. In 2001, the regional investigation was transformed into an area-wide investigation performed by several phosphate mining companies belonging to IMA (Selenium Area-Wide Advisory Committee) under the direction of IDEQ and other regulatory agencies pursuant to a CERCLA CO/AOC (2001 CO/AOC; IDEQ, 2001).

In 2004, the investigations began to focus on specific mines in the region, including the P4 Sites. Effective October 24, 2003, the USEPA, IDEQ, USFS, and P4 entered into a new CO/AOC (2003 CO/AOC; USEPA, 2003). The 2003 CO/AOC, under IDEQ lead, provided for the performance of Site Investigations (SIs) and Engineering Evaluation/Cost Analysis (EE/CA) programs for the P4 Ballard, Henry and Enoch Valley Sites that were consistent with CERCLA.

In 2009, at the request of USEPA, P4 and the A/Ts entered into a new CO/AOC (i.e., the 2009 CO/AOC) obligating P4 to perform an RI/FS and superseding the 2003 CO/AOC.

2.0 PHYSICAL CHARACTERISTICS OF THE STUDY AREA

This section describes the regional physical characteristics along with specific physical characteristics at individual locations and/or areas of interest in the immediate vicinity of the Site. Summaries are presented for: (1) physiography and surface features, (2) climate and meteorological information, (3) surface water hydrology, (4) geology, (5) soils, (6) hydrogeology, (7) ecology, (8) demographics and land and water use, (9) cultural and natural resources, and (10) background information on sources of contamination.

2.1 PHYSIOGRAPHY AND SURFACE FEATURES

The Site is located near the boundary between the Basin and Range and Rocky Mountain Physiographic Provinces. The north-south trending transition between the two provinces occurs at the western edge of the Aspen Range (approx. 7 miles south of the Site), with the western region (Basin and Range) consisting of wide, deeply filled, flat basins separated by block-faulted mountains, and the eastern region (Rocky Mountain) consisting of subparallel folded mountain ranges separated by thinly-filled valleys (Mabey and Oriel, 1970; Fenneman, 1917). West of the Site, the Basin and Range topography is influenced by large areas of flat laying volcanic basalts and is generally less mountainous than Rocky Mountain province to the east.

Topography at the Site is dominated by a main northwest-southeast trending ridgeline with elevations ranging from approximately 6,300 to 7,000 feet above mean sea level (amsl). There is a second lower, less continuous, parallel ridge located approximately 3,000 to 4,000 feet east of the main ridge. These two ridges approximately bound the Site on the northeast and southwest sides. Near the north end of the mine property, the Little Blackfoot River cuts across the property, flowing to the west into the Blackfoot Reservoir as shown on **Drawing 1-2**. The townsite of Henry and a seasonal marina and campground at the Blackfoot Reservoir are located within a mile of the northern end of the Site.

2.1.1 Waste Rock Piles and Mine Pits

The Henry Mine itself encompasses approximately 1,000 acres of disturbed area, comprising mostly waste rock dumps and mine pits. The configuration of the mine pits and waste rock dump areas are shown on **Drawing 1-2**. The mine pits are found along a five-mile stretch on the northeastern flank of the main ridgeline and were located to recover ore from the Meade Peak Member of the

Phosphoria Formation. The majority of the waste rock dumps are located downhill and to the northeast of the mine pits between the pits and lower ridge. The mine area primarily consists of gentle slopes that are the result of the mine reclamation. Exceptions occur in the partially backfilled mine pits on the north and south ends of the mined area (MMP041 and MMP044) where small, steep sections of highwall are exposed.

The mine pit and waste rock dump areas were defined during early regional investigations, and the definitions were retained during the EE/CA and RI/FS studies (see Section 3.0). As earlier defined, the Site contains four backfilled or partially backfilled mine pit areas - from northwest to southeast: MMP041, MMP043, MMP042 and MMP044. About one-third of MMP041 was left open, and approximately one-half of MMP044 (the southern half) was not backfilled (**Drawing 1-2**). Both the northern and southern ends of MMP041 were backfilled.

Five waste rock dumps were defined - from northwest to southeast: MWD085, MWD088, MWD086, MWD087, and MWD090 (**Drawing 1-2**). The external waste rock was generally placed downslope to the northeast of the mine pits and partially fills a small swale between the ridges (MWD087 is an exception to this as discussed below). As shown on **Drawing 1-2**:

- Waste rock dump MWD085 is located north of the Little Blackfoot River and is associated with mine pit MMP041. MWD085 includes both external dump and pit backfill.
- Waste rock dump MWD088, south of the Little Blackfoot River, is associated with the northern portion of mine pit MMP043 and includes a large lobe of external waste rock, as well as a portion of mine pit backfill.
- Waste rock dump MWD086 includes external waste rock and pit backfill associated with the remainder of mine pit MMP043, as well as pit MMP042.
- Waste rock dump MWD087 is unique in that it is external waste rock associated with MMP043 and MMP0042 that was placed on the southwest side of the mine pits. MWD087 includes two areas that filled small westward draining gullies. This is the only waste rock placed in the Long Valley drainage.
- Waste rock dump MWD090 is located mostly south of the P4 Enoch Valley haul road, and it includes external waste rock and pit backfill associated with mine pit MMP044.

Waste Rock Dump Volumes. The waste rock dump volume estimates presented in **Table 2-1** are based on the pre-mine topography that was digitized from a USGS topographic map and a new topographic survey prepared for P4 in 2008 which depicts the existing topographic surfaces. The waste rock dump boundaries include the backfilled mine pit areas. These areas are generally shown to have a net cut (excavated) volume, because the pits were not backfilled to original grade.

Therefore, the fill volumes for the waste rock dumps are calculated for the areas external to the mine pit areas only and do not include the waste rock areas within pit boundaries. Cut volumes in **Table 2-1** include both un-backfilled mine pit volumes, as well as the volume of the unfilled portion up to original grade above any pit backfill. The areas presented correspond to the volumes estimated (e.g., only external areas or estimated pit areas).

Rough estimates for the pit backfill volumes were calculated for the mine. P4 records indicate that 99.6 million cubic yards (MCY) of waste rock was moved at the Henry Mine. The estimated volume in the external waste rock dumps is 32.3 MCY (**Table 2-1**). Therefore, 67.3 MCY are estimated to be contained in the mine pits as backfill.

2.1.2 Ancillary Facilities

At this time, the only ancillary facilities remaining at the Henry Mine are the remnants of a partially paved haul road and various unimproved soft surface two-track roads. The remnant haul road begins approximately 700 feet north of the current P4 Enoch Valley haul road that traverses the mine between the MWD086 and MWD090 waste rock dumps. The connection between the current haul road and the mine haul road was reclaimed. From its southern point, the remnant haul road runs for approximately three miles to the North Henry Mine Pit (MMP041) (**Drawing 1-1)**. The unimproved roads are located throughout the mine area and provide access to the monitoring wells and other Site features. These roads were developed directly on whatever surface material is present and were not considered separate features for characterization.

2.2 CLIMATIC AND METEOROLOGICAL INFORMATION

The climate of southeast Idaho is semi-arid with hot summers and cold winters. The climate is strongly influenced by topography, which in turn influences wind patterns, temperature, and precipitation. Generally north trending mountain ranges in the region create a natural barrier for water-saturated Pacific air masses. The rain shadow effect causes the Snake River Plain region to be semi-arid with a middle latitude steppe climate. Precipitation during the colder months is generally in the form of snow, while precipitation during the summer is primarily associated with localized, orographic thunderstorms. **Table 2-2** presents data from the Enoch Valley Site meteorological station. The Enoch Valley Site climate station is located at the Enoch Valley Mine office approximately 2.5 miles east of the Henry Site, at an elevation of 6,720 feet amsl and is an appropriate analog for the Site.

Annual precipitation at the Enoch Valley Site is 19 inches per year. July and August are typically the driest months of the year and January is usually the wettest. On average, July and August are the warmest months of the year, while January and December are the coldest. Average temperatures range from minimums of -13.7 degrees Fahrenheit (ºF) in December to maximums of 89.1ºF in July.

2.3 SURFACE WATER HYDROLOGY

A limited amount of surface water occurs on the Site in the form of small named and unnamed streams, the Little Blackfoot River, a few springs, and manmade ponds. The Site is transected by the Little Blackfoot River in the north half. Elsewhere it contains headwater tributaries to a couple of small creeks. It does not contain any natural lakes or ponds.

2.3.1 Streams and Rivers

The southeastern portion of the Site is drained to the northeast by Lone Pine Creek and to the southwest by the Long Valley Creek system; and the northwestern portion of the Site is drained by the Little Blackfoot River as shown on **Drawing 2-1**. Lone Pine Creek flows much of the year, but often dries up in the summer through the autumn. It flows directly into the Little Blackfoot River east of the Site. A tributary to Long Valley Creek drains a small central portion of the Site; specifically, the westward facing MWD087 waste rock is in this watershed. Near the Mine, this tributary typically only flows for a brief period during spring runoff. Water in the tributary flows to Long Valley Creek and then eventually to the Little Blackfoot River, west of the Site. The Little Blackfoot River flows northeast to southwest, from Enoch Valley to Long Valley. It cuts directly through the northern and central portions of the Site. After passing through the Site, the river then flows northwest into Blackfoot Reservoir. A small portion of the Site watershed, including the reclaimed MWD085 and MWD088 waste rock dumps, drain directly toward the Little Blackfoot River as it cuts through the Site. **Table 2-3** provides the discharges and illustrates the seasonal differences in these Site drainages.

2.3.2 Springs and Seeps

Four springs and seeps have been identified and sampled at the Site. The flows from these springs and seeps are summarized in **Table 2-4** and the locations are shown on **Drawing 2-1.** Mine dump seeps (MDS) MDS016 and MDS022 originate from waste rock dump MWD090 on the southern end of the Site. These seeps flow to the headwater of Lone Pine Creek, as does spring (MSG) MSG002, which is located immediately adjacent to the Lone Pine tributary channel. Dump seep

MDS034 is associated with the northernmost end of waste rock dump MWD088 and flows directly toward Little Blackfoot River.

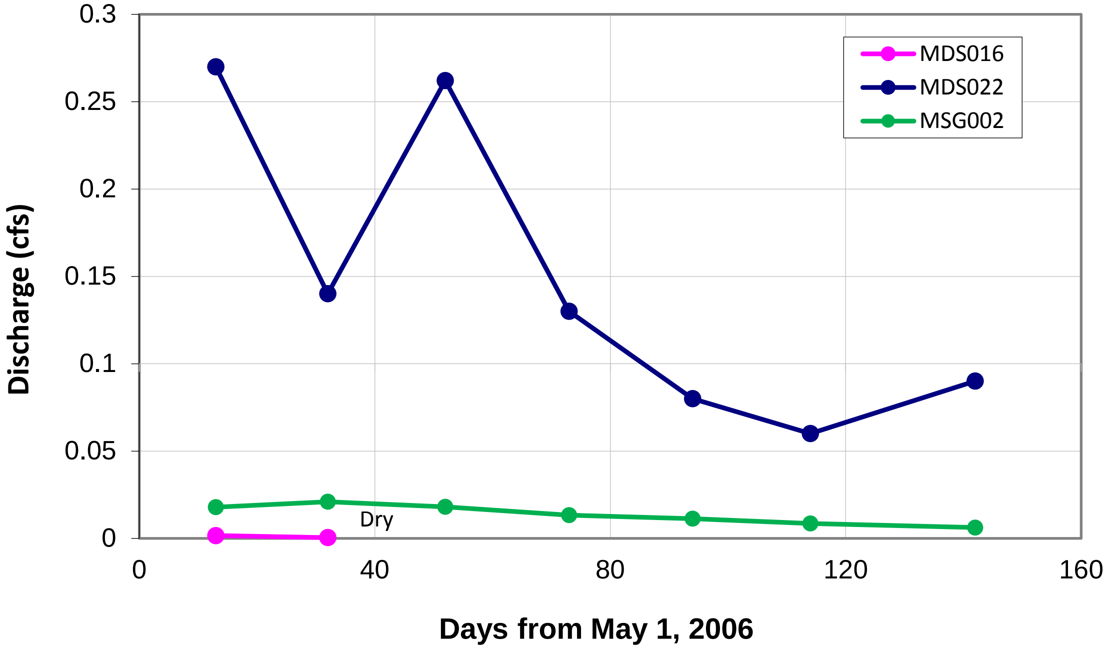
In 2006, surface water discharges were measured at three of the four spring/seep locations every three weeks from May to September as part of a stream recession analysis at the Site. The study was undertaken in an attempt to model the release of water from natural storage areas, typically assumed to be groundwater discharge once surface runoff has ceased.

Surface water discharges were measured and evaluated at the three Site stations listed in **Table 2-5**. **Table 2-5** presents the calculated recession constants, *k,* for each station with average and final recession constants based on measurements collected at the springs.

Figure 2-1 below is a discharge plot for each of the three stations monitored at the Site. The typical ranges of recession constants for stream flow components, chiefly runoff (0.2 - 0.8), interflow (0.7 - 0.94) and groundwater flow (0.93 - 0.995), do overlap (Nathan and McMahon, 1990). However, high recession constants (e.g., > 0.9) tend to indicate dominance of groundwater discharge. Additional details on the study and analysis are found in the discussion for the Ballard Site in Section 3.2 of the *RI/FS Work Plan*.

As suggested by the recession constants in **Table 2-5**, one of the three stations (i.e., MDS016) appears to have water supplied by an interflow source and the other two stations by groundwater. MDS016 has a final recession constant of 0.932, and was dry after only two measurements. MDS022 and MSG002 both have final recession constants above 0.98 and maintain a more constant discharge suggesting a perennial groundwater source. MDS022 shows some effect from spring recharge event. However, the longer term monitoring record indicates that the lower flow MSG002 will go dry in some years, whereas MDS022 has not been observed to go dry. MDS034 was not monitored during the study, but like MDS016, it appears to be a short duration interflow-dominated seep.

FIGURE 2-1
HENRY SITE SPRING, SEEP, AND HEADWATER DISCHARGE RECESSION PLOT



2.3.3 Ponds and Sediment Retention Structures

Four ponds are present on the Site. These ponds are listed in **Table 2-6,** and locations are shown on **Drawing 2-1**. The mine ponds (MSP) vary in size from approximately 0.12 acres (MSP055) to 5.8 acres (MSP014). Ponds MSP015 and MSP055 are seasonal, being dry by late summer. The ponds have varied riparian vegetation and vegetation densities surrounding them. With the exception of MSP055, the ponds have riparian habitats associated with the ponds are dominated by willows that are suitable for some wildlife. Pond MSP055 is a depression in the bottom of mine pit (MMP044) at the extreme southeastern end of the Site pit. This pond is often dry and has no significant riparian vegetation. However, the area around MSP055 was the location of a 2012 sheep kill associated with selenium hyper-accumulating vegetation that was growing near the pond (P4 Production, 2013). The functional uses of the ponds based on vegetation and other factors and the associated water quality are presented in Section 4.4.

Potential overflow watersheds are listed in **Table 2-6** for ponds that could theoretically overtop during a runoff or extreme storm events. These are anticipated directions of flow in case overtopping occurs, but these flow patterns have not been observed and outfalls suggesting overtopping are also not observed. As mentioned above, MSP055 is in a mine pit, and there is no reasonable expectation that it will overtop the mine pit.

Sediment retention structures were constructed below most of the waste rock areas excluding some of the mine pit backfill locations. These structures generally consisted of earthen berms constructed across a swale below the waste rock area or along the toe of a waste rock dump. Locations of these features are shown on **Drawing 2-1**. On the southeastern side of the Site, most of MWD090 is uphill of the P4 Haul Road, which acts as a sediment retention berm. There is a small berm along the toe of the lobe of MWD090 north of and downhill from the haul road. Similarly, there is a small berm constructed below the toe of the large lobe of MWD087. Large sediment retention berms were constructed below waste rock on the either side of the Little Blackfoot River. Two berms were constructed across swales below MWD088 southeast of the river, and a large berm, bisected by the former haul road, was constructed below MWD085 northwest of the river. Because of the lack of a significant watershed above the berms, they have never been observed to retain water and likely only would do so after a very large storm or snowmelt event. The large structures near the Little Blackfoot River have not been breached and appear to remain effective. The significance of the sediment control structures is discussed in additional detail in Section 5.0.

2.4 GEOLOGY

The geology in the Site area is transitional between Basin and Range and Rocky Mountain Physiographic Provinces, and it is characterized by linear, north-trending, fault-bounded ranges and basins formed by extensional tectonism. This extensional tectonism overprints an earlier period of compressional tectonics that included major overthrusting associated with the Bannock Thrust Zone in southeast Idaho, which resulted in synclinal-anticlinal folds and some faulting during the Upper Cretaceous and Paleocene periods. The dominant structural feature at the Site is a northwest trending syncline, which is directly related to the Henry Thrust Fault located to the northeast of the Site (**Drawing 2-2**).

Regional geologic mapping of the program area was conducted in 1927 by the USGS (Mansfield, 1927). Subsequent mapping programs in the area were conducted by Oberlindacher, et al. (1982), Hovland (1981), Oberlindacher, 1990, and Oberlindacher, et al., unpublished. Site-specific field observations and boring logs have been used in updating the Site conceptual hydrogeologic models, cross-section drawings, and in determining locations of proposed wells. These data and updates were discussed and presented in previous Site documents including the *RI/FS Work Plan*. The compiled Site geologic map is presented on **Drawing 2-2** along with a generalized cross-section on **Drawing 2-3**.

The Site and immediate area includes all the Quaternary through Pennsylvanian units listed in **Table 2-7,** exposed primarily on the northeastward dipping limb of a northwest trending syncline in which the mine is situated. The syncline present at the Site is an offset portion of the Wooley Valley Syncline. The other major structural features in the Site area are the northwest trending Henry Thrust Fault, which parallels the mine, and the Georgetown Syncline further to the east beneath Lone Pine Valley (**Drawing 2-2**).

This geology has resulted in an exposure of the Phosphoria Formation Meade Peak Member ore beds along the larger northwest trending ridge, which is capped by beds of steeply northeast dipping Wells Formation. The core of the exposed syncline located east of the main ridge is composed of Triassic Dinwoody Formation. This upturned southwest dipping side of the syncline forms the lower ridge that runs parallel to the main ridge throughout much of the Site. It is the low area between these ridges that contains most of the Site's waste rock. This lower ridge is composed of Dinwoody Formation that has been thrusted over the younger Thaynes Formation along the Henry Thrust Fault. This geologic configuration is broken to the south of the Site by the strike-slip Rasmussen Fault, which offsets these geologic units by approximately 3,000 feet to the southeast. The Site area is also bounded to the west by the normal Slug Valley Fault.

Another significant geologic feature is where Quaternary basalt flooded through the break in the ridge formed by the Little Blackfoot River at the northwestern end of the Site. This formed a lobe of basalt on the mine side of the main syncline ridge (**Drawing 2-2**).

Essential to the development of the Henry Mine was the phosphatic ore beds of the Phosphoria Formation. The Phosphoria Formation has four members (from oldest to youngest): the Meade Peak Phosphatic Shale, Rex Chert, Cherty Shale, and Retort Phosphatic Shale (**Table 2-7**). The Meade Peak Member, which ranges in thickness from about 55 to 200 feet, is the source of most of the extracted phosphate ore in southeastern Idaho and was the source of ore at the Henry Mine. This is the oldest member of the Phosphoria Formation and is overlain by the Rex Chert and then the Cherty Shale. The Retort Member is discontinuous and is found in the northern and eastern parts of the region but not in the vicinity of the Henry Site (USGS and USFS, 1977).

Another significant sedimentary unit at the Site is the Triassic Dinwoody Formation, which is made up of upper and lower units consisting of limestone, siltstone, and shale layers. The lower Dinwoody Formation directly overlies the Phosphoria units in the stratigraphic section, and as noted earlier, forms the bulk of the outcrops on the east side of the Site. The upper and lower units are often separated by a distinct layer of Woodside Shale; however, this unit has not been observed at the Site.

The Meade Peak Member of the Phosphoria Formation is underlain by the upper unit of the Wells Formation, which consists of sandstone interbedded with limestone and dolomite. In some locations, the Grandeur Limestone of the Park City Formation is present above the Wells Formation and is usually considered part of the Wells Formation for mapping purposes. Drilling at the Site encountered limestone and sandstone of the Wells Formation but not the dolomitic beds of the Grandeur Limestone. As noted previously, the Wells Formation forms the ridge on the west side of the Site. This is in part due to the limestone beds in the unit that are more resistant to weathering.

2.5 SOILS AND VEGETATION

2.5.1 Soils

Soils in the vicinity of the Site are typically brown clayey, gravely and cobbly loams (USDA, 1990). Coarse fragments in the subsoils range from pebbles to cobbles in variable percentages. The soils are moderately deep and well drained (USDA, 1990). The surficial soil on the Site waste rock deposits is variable percentages of rock that was extracted during mining.

Surficial cover soils on waste rock dumps at the Site consists primarily of weathered brown shale, as documented during the 2009 soil and vegetation survey (*RI/FS Work Plan*, Appendix A2). Up to two percent limestone mixed with the weathered brown shale comprises a small percentage (less than five percent) of the total area of the dumps. Limestone and sandstone is found on and in the cover primarily near the base of highwalls, along with scattered dolomite boulders. Black shale cover is rare and comprises less than one percent of the total area of any dump. It closely resembles and functions as topsoil over the majority of the dumps.

Based on a 2009 soil survey, weathered brown shale cover thicknesses average two to three feet on flat areas of the waste rock dumps. The adjoining slopes are typically gentle with cover in places less than or equal to one foot thick. Steeper slopes on MWD087 are benched with cover less than or equal to six inches thick on the sloped portions and greater than one-foot-thick on the flat areas. Uncovered areas at angle-of-repose are not present on any of the waste rock dumps, and only occur on the remaining Wells Formation highwalls and road cuts through the Dinwoody Formation.

2.5.2 Vegetation

The 2009 vegetation survey was conducted on the five waste rock dumps and haul road. The relative abundance of the overall vegetative cover for each survey area, as well as the relative abundance of each species encountered of all life forms (i.e., grasses, forbs and shrubs) was estimated. Culturally significant plant species also were identified as part of the survey. The species list was provided by the A/T and documented in the A/T-approved technical memorandum that was prepared following the plant survey (*Culturally Significant Plant Sampling Henry, Ballard, and Enoch Valley Mine Sites Late Summer/Fall 2009 Technical Memorandum* [MWH, 2009a])[2]. The species of grasses, forbs and shrubs identified at the Site and the relative abundance of each plant are detailed in Appendix A2 of the *RI/FS Work Plan* and a discussion of the plants observed at the Site is provided below.

- GRASSES: Of the 16 grasses identified at the Site, smooth brome (*Bromus inermis*) is found to be the dominant species comprising 50 percent or more of the total mine area vegetation. The second most abundant grass (25 to 50 percent) found at the Site was orchard grass (*Dactylis glomerata*). Both of these grasses were used in the seed mixes for waste rock dump reclamation.
- FORBS: Alfalfa (*Medicago sativa*) is the most abundant of the 51 different forb species found at the Site. The second most abundant forbs, were Great Basin lupine (*Lupinus ×alpestris*) and tapertip hawksbeard (*Crepis acuminate*).
    - Three forbs classified as selenium accumulators were also found at the Site: milk-vetch (*Astragalus sp.*) was observed at 5 to 10 percent relative abundance and is a Group 1- primary selenium accumulator species (NRC, 1983; MWH, 2009b); scarlet Indian paintbrush (*Castilleja miniata*) and sulphur Indian paintbrush (*Castilleja sulphurea*) were both rarely observed, at a relative abundance of <5 percent, and are Group 2- secondary selenium absorber species.
- SHRUBS: There were nine species of shrubs identified at the Site. Shrubs were found least often of all vegetation types. No shrub was classified as abundant in the mine area.
- CULTURALLY SIGNIFICANT PLANTS: Four of the five culturally significant plants observed at the Site were uncommon or rare (white sage brush, chokecherry, quaking aspen, and Rocky Mountain juniper). The most abundant species, big sagebrush (*Artemisia tridentata*), was classified as common in the mine area.

---

[2] Note that the culturally significant plant species provided by the A/Ts in 2009 varies from the culturally significant plant species listed in the Shoshone-Bannock Tribes *Exposure Scenario for Use in Risk Assessment* (Shoshone-Bannock Tribes, 2016). Generally, the 2009 plant list is a subset of the current (2016) Shoshone-Bannock Tribes list, although several of the culturally significant plant species from the 2009 list are no longer included on the 2016 list (e.g., bitterroot, gooseberry, onions) and several other species are included on the 2016 plant list (e.g., grasses, thistles, and wild rose). All five of the culturally significant plant species sampled in 2009 are included on the 2016 plant list.

2.6 HYDROGEOLOGY

The hydrogeologic setting of the Site is strongly influenced by the complex structural setting. The groundwater system and flow generally is confined to three hydrostratigraphic units (discussed in Section 2.6.1 below). However, where these units occur and how groundwater flows in them largely is controlled by the structural geology. The hydrogeology is discussed in both the broader regional context, and at the local Site level in the following sections.

2.6.1 Regional Hydrogeology

The regional groundwater system can be divided into, (1) local shallow groundwater systems within basin-fill alluvium, (2) shallow to deep intermediate systems within sedimentary bedrock units, and (3) regional groundwater flow systems within deeper sedimentary bedrock units. Local systems generally are recharged and discharged within a single adjacent ridge and valley area. An example of an intermediate flow system is one that is recharged on one side of a ridge and then discharges to an adjacent valley on the opposite side of the ridge, whereas regional systems may transmit groundwater over large distances through multiple interconnecting valleys.

The principal hydrostratigraphic units underlying the Site range in age from Quaternary (alluvium and basalt) to Pennsylvanian (Wells Formation) in age and are described in **Table 2-7** along with the type of flow system they commonly support. The Quaternary alluvium and colluvium in the valleys can be up to approximately 150 feet thick and are recharged by direct precipitation and shallow flow from the topographic high points (i.e., the area ridges).

The alluvial groundwater systems may interact directly with the local surface water systems in the valleys with gaining and losing streams at different locations. The uppermost alluvial groundwater typically is unconfined based on water level information from the boreholes and monitoring wells installed at the Site, which indicates that the water table surface and groundwater flow generally mirrors and follows the surface topography. This results in groundwater flow from high to lower topographic areas. However, deeper zones in the alluvial groundwater system may be locally semi-confined or confined because of alternating clayey and sandy bedding in the alluvium. Where the sedimentary bedrock units contact alluvium, groundwater will similarly move between the alluvium and bedrock depending on the hydraulic characteristics of the units and the hydraulic gradients at different locations. During the drilling conducted at the Site and at other P4 Sites, a transitional contact zone has been observed between the alluvium and weathered bedrock. This zone of weathered bedrock immediately underlying the alluvium often has a higher hydraulic conductivity than the alluvium and in this situation, the alluvium can act as a confining layer.

The Dinwoody, Phosphoria, and Wells Formations are the principal sedimentary bedrock units in the area of the Site through which significant groundwater may flow. Previous hydrogeologic research conducted in the area encompassing the Site indicates the following regarding potential bedrock groundwater systems in the area:

- The Dinwoody Formation typically supports intermediate groundwater flow systems (Ralston et al., 1977; Ralston et al., 1980).
- The Phosphoria Formation does not support any major groundwater flow systems. However, the Rex Chert Member may transmit groundwater locally where fractured (Ralston et al., 1977; Ralston et al., 1980). The main ore-bearing unit of the Phosphoria Formation, the Meade Peak Phosphatic Shale, is relatively impermeable due to low vertical hydraulic conductivity associated with the shale (Ralston et al., 1980).
- The Wells Formation supports a regional groundwater system (Ralston et al., 1977; Ralston et al., 1980). The Wells Formation has the highest hydraulic conductivity compared to the other bedrock units in the region (BLM, 1999).

The groundwater flow system in the Dinwoody Formation generally is separated from the deeper Wells Formation by the low hydraulic conductivity of the Phosphoria Formation (in particular the Meade Peak Member - see **Table 2-7**). This causes the upper flow systems in the Thaynes and/or Dinwoody Formations typically to be local or intermediate in extent, while the lower flow system in the Wells Formation commonly exhibit regional flow characteristic because of its position below the Dinwoody and Phosphoria Formations.

Recharge to the bedrock units generally occurs along outcrops, particularly along topographically high ridges and flows downward along the dip of the geologic beds. Eroded, steeply-dipping beds are more likely to be significant zones of recharge when compared to flat laying beds because of the differences between permeability parallel and perpendicular to the bedding. For example, the steeply dipping outcrops of Wells Formation along the ridge on the west side of the Site should be and likely are a recharge area.

Groundwater flow through bedrock units is controlled by several factors, including the hydraulic properties of the units (i.e., with-bedding and cross-bedding hydraulic conductivities) and hydraulic gradients, the areal extent, thickness and orientation of the geologic units, as well as structural controls such as folding, fracturing, and faulting. Fracturing of bedrock units (especially chert, mudstone, and limestone) has the potential to create secondary permeability and increase the hydraulic conductivity in an otherwise low-conductivity unit.

Faulting in the bedrock units (i.e., where movement or displacement has occurred) also can create flow barriers where gouge has formed as the result of rock grinding together. Some faults may have associated fracturing or dilatant zones that enhance permeability. Generally, the larger the fault displacement or more compressional a fault (e.g., thrust faults versus normal faults), the more likely it will be to have significant gouge and be a flow barrier. Factors such as rock type, depth, hydrostatic pressure, and other geologic conditions also can influence the hydrogeologic character of a fault or fault zone. The Henry Thrust Fault parallel and east of the Site is a significant feature relating to the regional hydrogeology. The presence of this northwest trending thrust fault likely results in a barrier to flow perpendicular to the fault because of gouge, although in some areas it may be a conduit for flow parallel to the fault due to fracturing of adjacent beds. Normal faulting, which is more likely to create groundwater flow conduits, is not a significant feature of the Site.

Any flow systems encountered in the Phosphoria Formation will not be regional in extent, but could be intermediate or local in some situations. It is most likely that where groundwater is encountered in the Phosphoria Formation, it is isolated, structurally-controlled, and thereby generally confined to specific beds or units. Regardless, flow vertically through the Phosphoria Formation (i.e., perpendicular to bedding) is expected to be very limited due to the presence of low permeability shale and mudstone beds. The potential risk of widespread groundwater contamination in this type of system is much less than in the more laterally extensive flow systems associated with the other bedrock units (e.g., the Wells Formation regional groundwater flow system). As such, the current conceptual models and hydrogeologic investigations are not focused on flow within the Phosphoria Formation. Previous studies in the Southeast Idaho Phosphate Resource Area have indicated that spring discharge to surface water from the Phosphoria Formation is an infrequent occurrence (Winter, 1980; Ralston et al., 1980). It is estimated that approximately two percent of spring discharge and total stream gain was found to be supplied by the Phosphoria Formation regionally (Winter, 1980).

2.6.2 Site Hydrogeology

All three of the groundwater systems found regionally (discussed above) are present at the Site. The alluvial system occurs locally within and adjacent to the mine area where the Little Blackfoot River cuts through the Site, and along the southern portion of the Site where the P4 Enoch Valley haul road traverses the Site (**Drawing 2-2**). The most characteristic alluvial valley near the Site is along Lone Pine Creek to the east. Basalt beds are located near the Little Blackfoot River where it crosses through the Site. These beds may have relatively high hydraulic conductivity (due to fractured flow and in-situ weathering) and are in direct hydraulic communication with the alluvial system when it is present. However, the basalt at the Site has limited areal extent, and does not represent a significant hydrogeologic system by itself, and is included with the alluvial system.

The occurrence at the Site of the Dinwoody and Wells Formations, which make up the intermediate and regional systems, respectively, is discussed in Section 2.4 above. The Dinwoody Formation occurs on the northeastern side of the Site forming a low ridge, whereas the Wells Formation occurs on the southwestern side of the Site forming a more pronounced ridge (**Drawing 2-2**). Flow in the Dinwoody Formation is thought to be largely northeastward with a possible northwest component following bedding and toward topographically lower areas, but a northeast component toward the Henry Thrust is also possible. Groundwater flow in the Wells Formation is toward the Henry Springs to the northwest. Specifics of groundwater movement in these systems are discussed in association with the Nature and Extent of Contamination (Section 4.5) and Contaminant Fate and Transport (Section 5.1). Physical hydrogeologic data collected during the SI/RI supporting the characterization of groundwater flow include hydraulic conductivity data collected from the monitoring wells, and piezometric and temperature data collected from data logging pressure transducers placed in a subset of the wells.

2.6.2.1 Hydraulic Conductivity

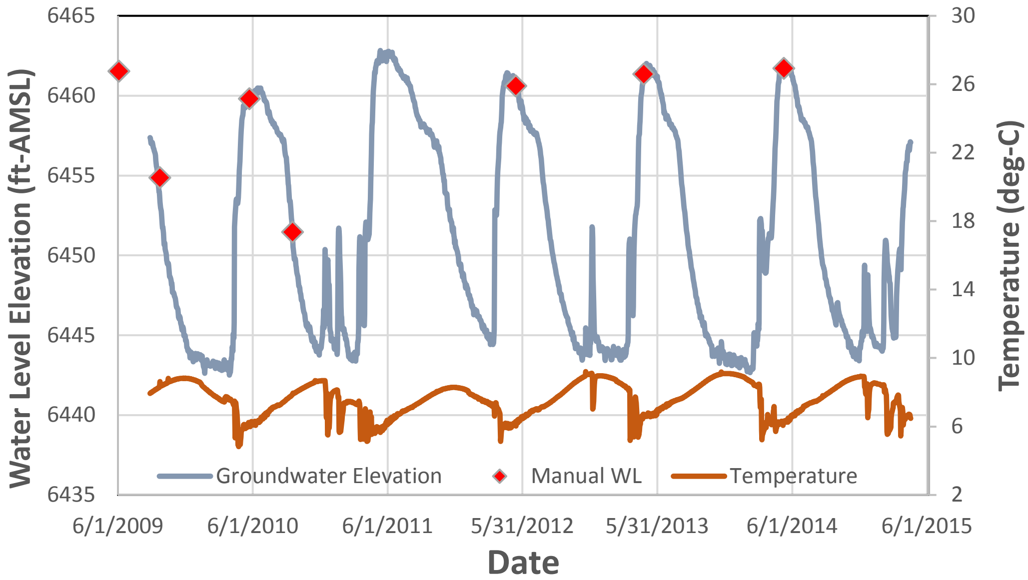
Hydraulic conductivities were calculated using slug test data from four of the Site monitoring wells as described in *2009 Well Testing Technical Memorandum*, attached as Appendix A4 of the *RI/FS Work Plan*. The results summarized in **Table 2-8** include data for two monitoring wells installed in the Wells Formation, one Dinwoody Formation well, and one alluvial well. **Drawing 2-1** provides the well locations. The results ranged from $6.1x10^{-4}$ to $3.0x10^{-2}$ cm/sec with relatively high hydraulic conductivities recorded in both the Dinwoody and Wells Formations. These results along with results from the other two P4 Sites help frame the contaminant fate and transport discussion presented in Section 5.3.

2.6.2.2 Piezometric and Temperature Monitoring

Transducers with data loggers initially were placed in seven monitoring wells at the Site. The data collected include daily groundwater levels and temperature in these wells, and are used to evaluate how the monitored aquifer responds to precipitation/infiltration events, and ultimately how aquifers may be interconnected. The instrumented monitoring wells include: MMW004 and MMW010 in the alluvial unit, MMW019 screened across a contact between the Phosphoria Formation and alluvial units, MMW022 and MMW028 in the Dinwoody Formation, and MMW011 and MMW023 in the Wells Formation. One barometric data logger was placed in MMW011. In addition, water levels have been measured with a level sounder routinely during individual groundwater sampling events. The locations of the monitoring wells are shown on **Drawing 2-1**. The transducer/data logger was pulled from monitoring well MMW004 (northern alluvial aquifer) in September 2009. The unit was placed in a new monitoring well at the Enoch Valley Site. Data for MMW004 previously were presented in the *RI/FS Work Plan (Appendix A4)*, and because the data were typical with no significant conclusions developed, they are not discussed again herein. Data for the other six monitoring wells with recent data are discussed below.

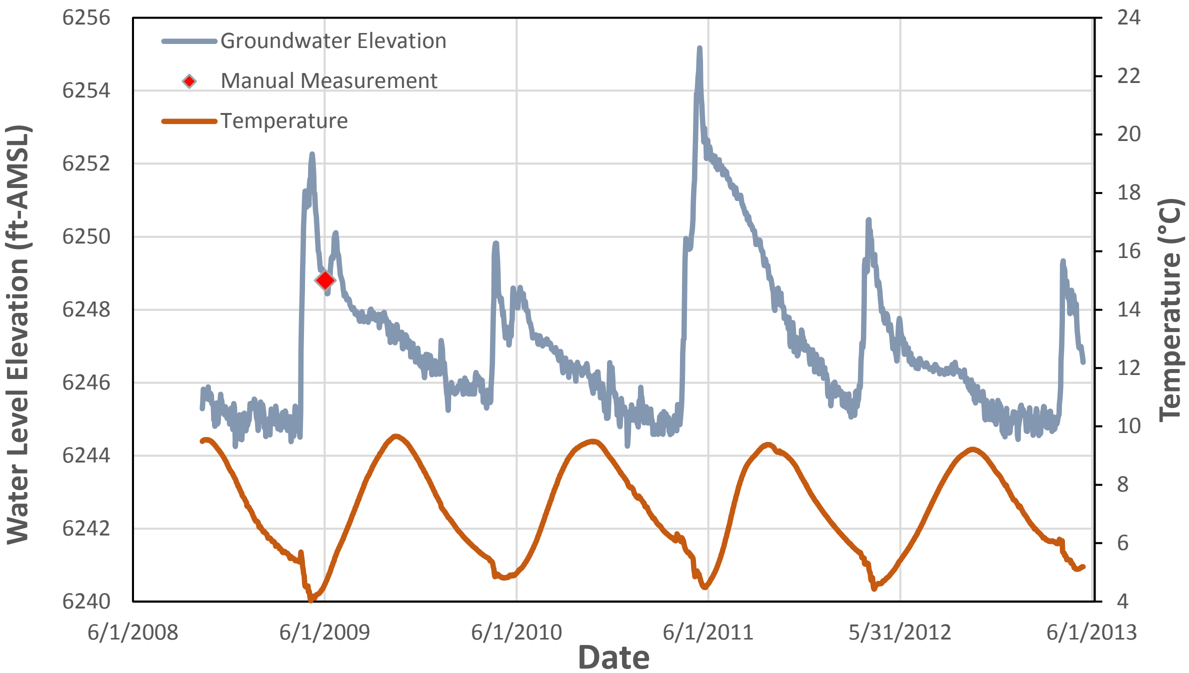
Data for alluvial monitoring well MMW010 (south area) are presented in **Figure 2-2**. The groundwater levels and temperatures show pronounced seasonal responses with relatively little year to year variability. The upper limit to the groundwater level is the ground surface, which is approached every spring. There also appears to be a lower bound that may be the bottom of the uppermost permeable unit in the alluvium. (Spikes in the water levels seen in the winter and spring months may be due to the water surface in the shallow well briefly freezing.) As noted later in Section 4.5.2.1, the selenium concentrations appear to correlate with the groundwater levels, with the highest selenium concentrations occurring with high groundwater levels. The groundwater temperature responds to the spring recharge. The temperature falls during the rising limb of the hydrograph indicating the inflow of cool surface water, and rise after the peak spring recharge.

FIGURE 2-2
GROUNDWATER HYDROGRAPH AND TEMPERATURES FOR ALLUVIAL MONITORING WELL MMW010



The hydrograph for MMW019 is presented in **Figure 2-3**. After 2013, MMW019 data were no longer downloaded. The hydraulic response of the monitoring well indicates a very local source of recharge (i.e., interflow from the adjacent slope). The top of the sand pack in the well is at three feet below ground surface (bgs), which is at a depth that could intercept interflow. The temperature data appear to respond the seasonal fluctuations in air temperature with a slight downward bump during the recharge event. The minimum temperature occurs in early spring and the maximum in early fall.

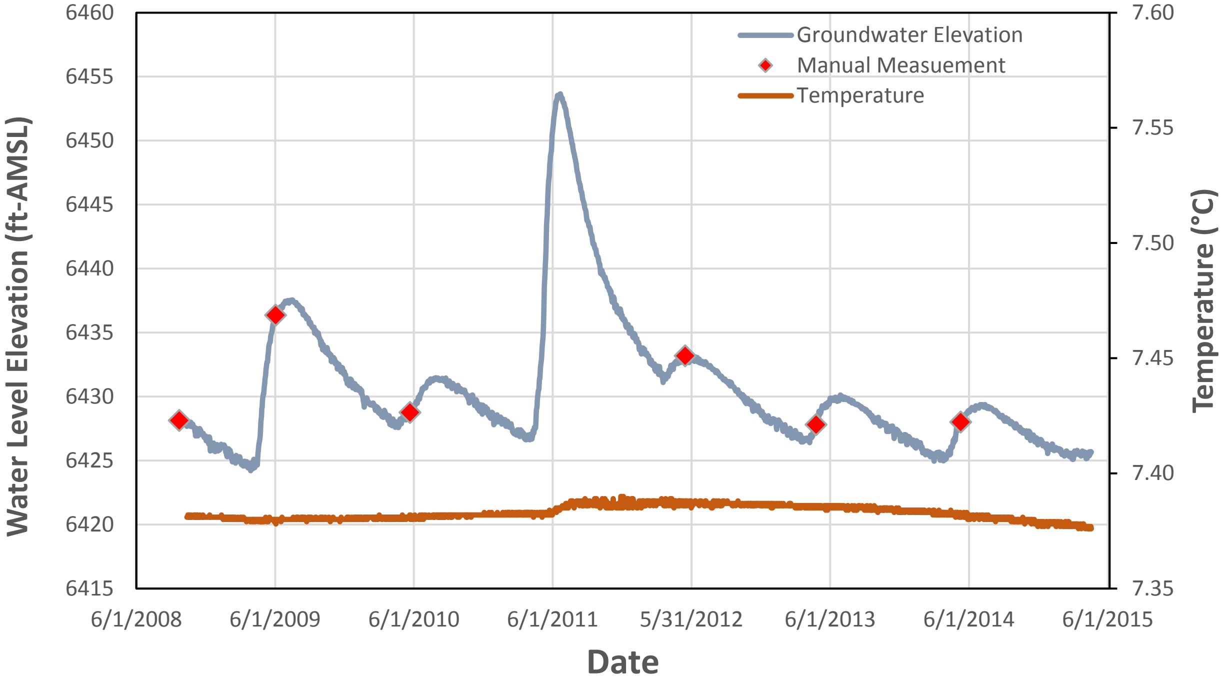
FIGURE 2-3
GROUNDWATER HYDROGRAPH AND TEMPERATURES FOR ALLUVIAL MONITORING WELL MMW019



The hydrograph and temperature data for Dinwoody Formation monitoring well MMW022 are presented in **Figure 2-4**, and the winter precipitation at the Blackfoot Bridge Mine, and the nearby Enoch Valley Mine, is presented on **Table 2-9**. The hydrograph shows a typical seasonal response with the peaks proportional to the size of the recharge (snowmelt) event. The hydrograph is punctuated by a large recharge event in 2011 and a second smaller, but notable recharge event in 2009. The 2011 recharge event was associated with winter precipitation approximately twice that of other recent years as indicated in **Table 2-9**, and the 2009 recharge event was also associated with proportionally elevated winter precipitation. These larger recharge events in 2009 and 2011 are observed in wells throughout the P4 Sites, and are associated with increases in analyte concentrations in some locations (e.g., MMW020 at the Ballard Site, *Ballard RI Report*).

It appears that after the larger 2011 recharge event at MMW022 that the selenium concentration increased at the location from approximately 0.020 to 0.045 mg/L (see Section 4.5.1.1). The groundwater temperature in this deep well is relatively invariant at approximately 3.38 °C with the exception of a slight upward bump associated with the 2011 recharge event.

FIGURE 2-4
GROUNDWATER HYDROGRAPH AND TEMPERATURES FOR DINWOODY MONITORING WELL MMW022



The hydrograph for the second Dinwoody Formation monitoring well, MMW028, is presented in **Figure 2-5**. The data logger in the well failed and would not download after 2013. The unit was not replaced. The hydraulic response in MMW028 is very similar to MMW022. The temperature shows a gradual downward trend with downward spikes of approximately 0.01 to 0.2 degrees during the snowmelt and the spring recharge events. **Figure 2-6** compares the two Dinwoody Formation monitoring wells MMW022 and MMW028. It is apparent that the shallower MMW028 responded slightly earlier (approximately a week) to recharge and with sharper peaks and greater amplitude (MMW028 is 96 feet deep whereas MMW022 is 326 feet deep.) This water level response, along with the temperature response (**Figure 2-6**), suggests that MMW028 is closer to a recharge source, which is reasonable given its shallower depth. It is also notable that the water level in MMW028 is deeper than MMW022 indicating an apparent gradient northward toward MMW028 (i.e., MMW022 has a higher hydraulic potential). The apparent flow direction in the Dinwoody Formation is shown on **Drawing 2-2**.

FIGURE 2-5
GROUNDWATER HYDROGRAPH AND TEMPERATURES FOR DINWOODY FORMATION MONITORING WELL MMW028

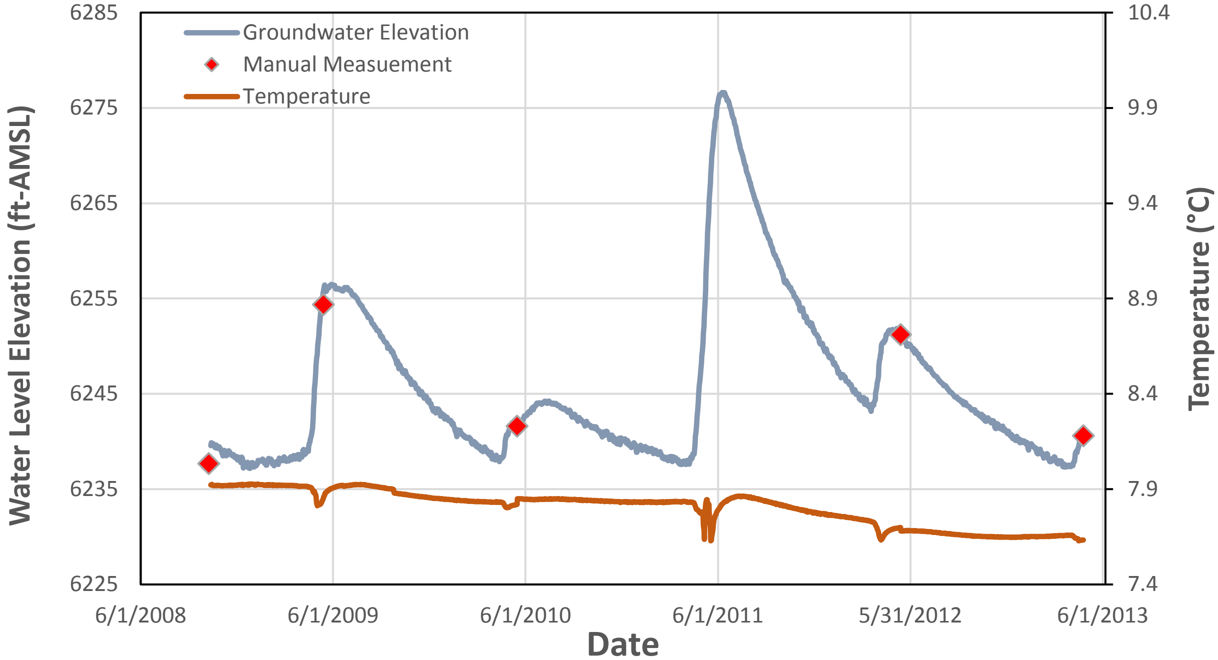
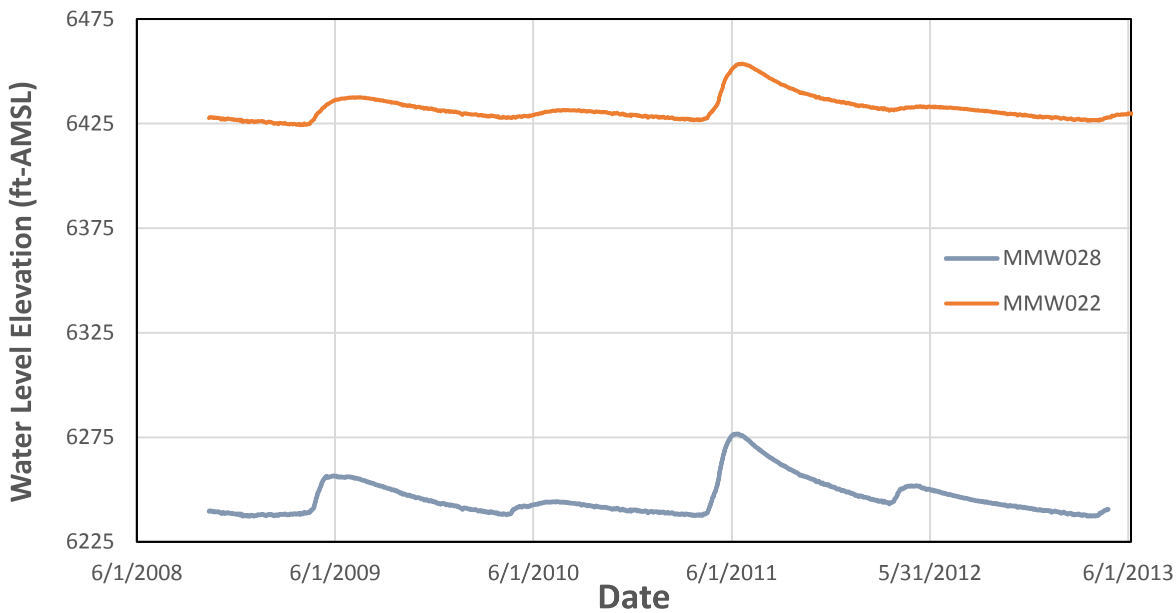
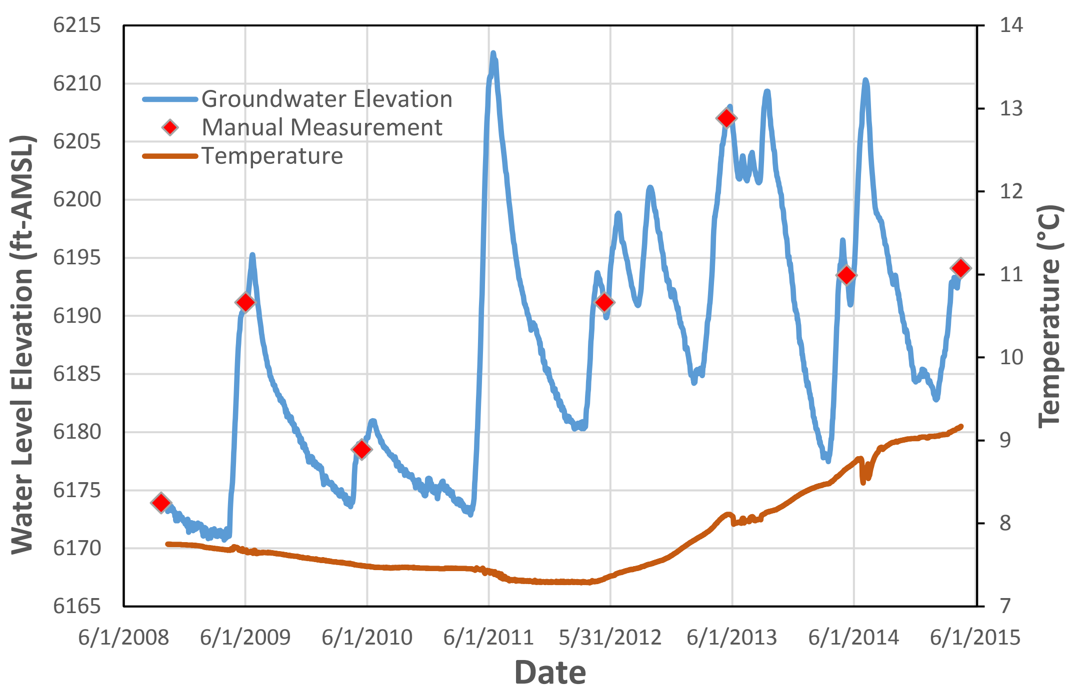


FIGURE 2-6
GROUNDWATER HYDROGRAPHS FOR DINWOODY FORMATION MONITORING WELLS MMW022 AND MMW028



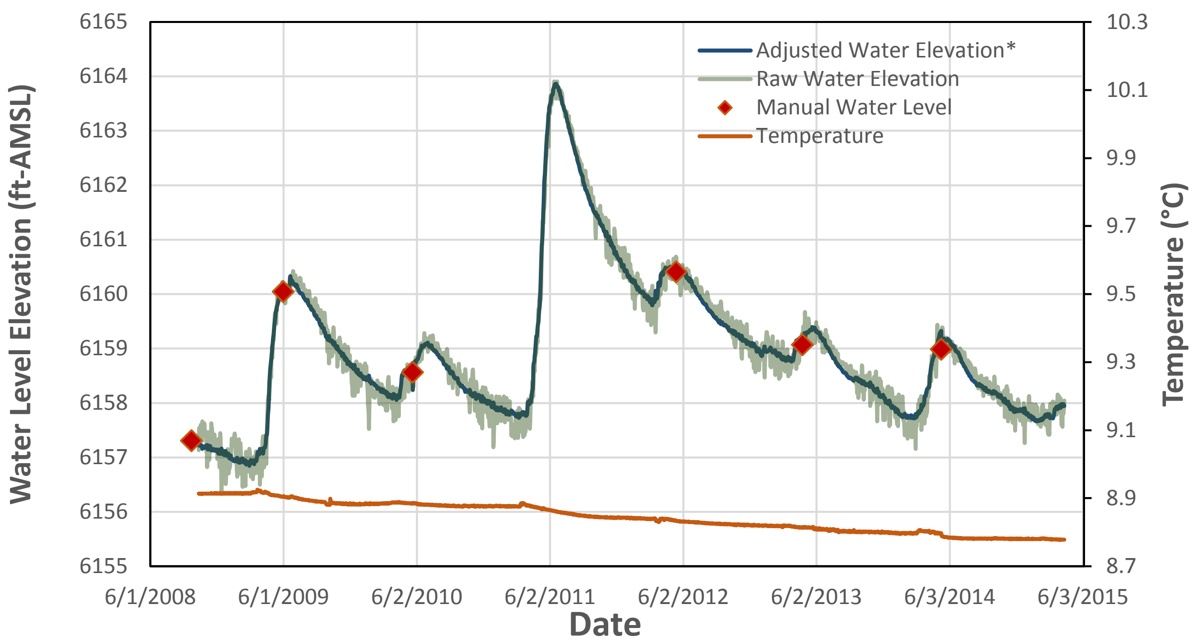
Monitoring wells MMW011 and MMW023 are installed in the Wells Formation. Monitoring well MMW011 is screened at 95 – 115 feet below grade with water level 75 – 90 feet below the ground surface. The well is located on the south bank of the Little Blackfoot River a few feet above the river level. As seen in **Figure 2-7**, there is about a 45-foot range in water levels with a rapid response to snowmelt. The Little Blackfoot River crosses the Wells Formation (i.e., underlies the river channel) near MMW011, and the hydrograph from this monitoring well indicates increased loss from the river to the Wells Formation especially during high flow events. This portion of the river corridor is believed to be an area of recharge to the formation. After May 2012, the water levels generally increased and they became more erratic. The temperature also began to gradually increase. This variability is possibly the result of changes in the Little Blackfoot River flows. The spiky character of the MMW011 hydrograph suggest an anthropogenic influence, specifically periodic water releases to the river affecting recharge to the Wells Formation. Continuous flow gauging is not conducted on the river anywhere, nor have any new discharges to the watershed been identified. Therefore, P4 has not identified a specific cause for the abnormal hydrograph in MMW011.

FIGURE 2-7
GROUNDWATER HYDROGRAPH AND TEMPERATURES FOR WELLS FORMATION MONITORING WELL MMW011



The second Wells Formation monitoring well is MMW023 located north of the Little Blackfoot River in the unbackfilled portion of the MMP041. This well shows a typical seasonal response pattern consistent with the other deeper Site monitoring well MMW022 (**Figure 2-8**). The same peaks associated with the high 2009 and 2011 winter precipitation events (**Table 2-9**) are seen, but the effects of the greater recharge takes several years to dissipate. Compared to MMW011, the range of water levels over the monitoring period is only about 7.5 feet. Water levels in MMW023 have a strong barometric response producing a "noisy" hydrograph, which is typical of a confined aquifer and is more apparent because of the relatively small range of water levels. Both the raw data and the data corrected for barometric changes are presented in **Figure 2-8**. The temperature in the well is relatively invariant with small bumps during spring recharge and a slight downward drift similar to the pre-2012 MMW011 temperature data.

FIGURE 2-8
GROUNDWATER HYDROGRAPH AND TEMPERATURES FOR WELLS FORMATION MONITORING WELL MMW023.

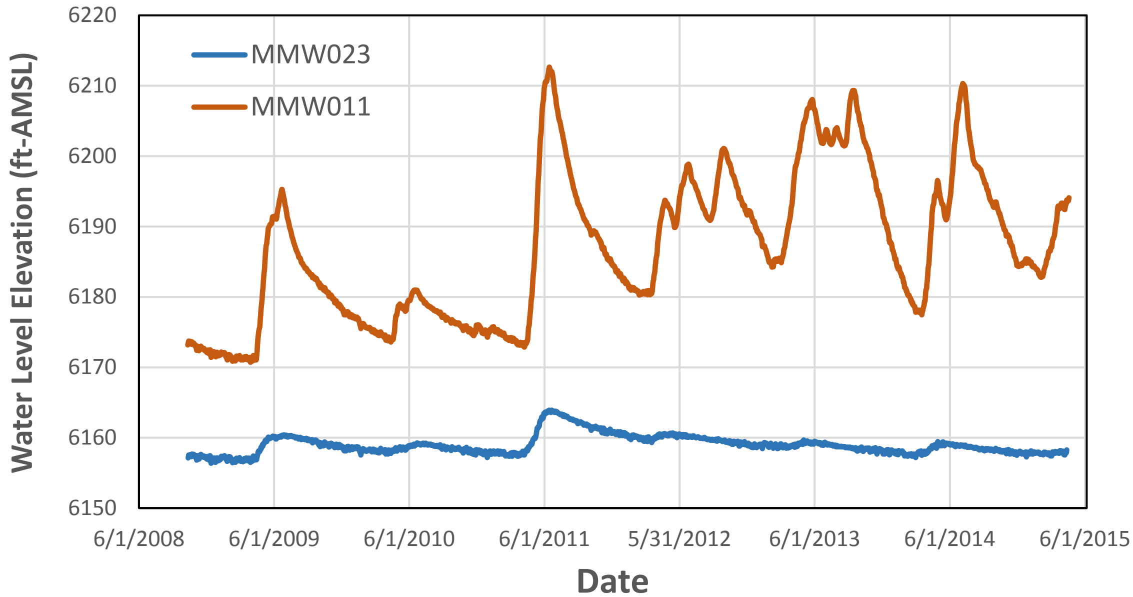


*Raw water levels are adjusted to compensate for barometric rchanges using barometric readings from MMW011 barometric logger.

Monitoring wells MMW011 and MMW023 are on the conceptual flow line in the Wells Formation that is assumed to terminate at the Henry Springs approximately 1.5 to 2 miles northwest. This Wells Formation flowpath is illustrated on **Drawing 2-2**. (This flow path has been put forth by several other researchers including: Mayo, 1982; Ralston, et. al., 1983; Ralston, 2010). Therefore, the gradient between the two monitoring wells is important for helping to validate the conceptual flow direction.

As seen in **Figure 2-9** comparing the two hydrographs, the water levels in MMW011 are 10+ feet higher than MMW023 indicating an apparent gradient to the northwest and the Henry Springs.

FIGURE 2-9
GROUNDWATER HYDROGRAPHS FOR WELLS FORMATION MONITORING WELLS MMW011 AND MMW023



The Henry Springs discharge at an elevation approximately 6,135 feet AMSL, or approximately 25 feet lower than the water level in MMW023. They have formed a large area of travertine located approximately 1 mile west of the northern portion of the Site (refer to **Drawing 2-2** for the location of the discharging Henry Springs). The springs and associated flow system were sampled and evaluated by Mayo (1982) and Ralston, et al. (1983). These authors recorded the positions of five springs, but there are likely several more. For example, they noted that the spring identified along the banks of the Little Blackfoot River was only one of several in that location.

Sampling for the major ions indicate that the water discharging from the springs is a highly evolved calcium-carbonate water type discharging from the Wells Formation. The sulfate content of the springs is low, averaging approximately 50 mg/L. The water discharging from one of the springs was dated at 20,500 years old (Mayo, 1982). The flow volume (> 4,000 gpm), chemistry, and age date indicate this is groundwater discharge from a large portion of the Wells Formation (which represents a large area) and other regional aquifer formations.

It also should be noted that photos from the Henry Mine operational period, anecdotal reports, and the presence of dewatering wells at the southern mine pits indicate that the bedrock groundwater level in these pits was high enough to interfere with mining. The dewatering wells MPW022 and MPW023 were apparently not successful in dewatering the mine pits. This suggests that the source of groundwater was likely from the Wells Formation, not the Phosphoria Formation. Pit bottom elevations for the southern pits were on the order of 6,400 to 6,500 ft-AMSL (note the elevation of MSP055 is approximately 6,510 ft-AMSL, **Drawing 2-2**.) This suggests that the water level in the Wells Formation in the southern portion of the mine may be as much as 200 feet higher than at MMW011. While indirect data, this information provides further support for inferring a northwestward groundwater flow direction in the Wells Formation along the bedding plane.

2.7 ECOLOGY

The ecology of the SW Idaho area and the Site area have been previously presented in several relevant reports. The biological resources in the Southeast Idaho Phosphate Resource Area are discussed in the *Area-Wide Assessment* (TetraTech, 2002), and the *1998 Regional Investigation Report* (MW, 1999) presents a detailed discussion of the regional ecology. The Blackfoot Bridge Environmental Impact Statement (EIS) also provides a detailed discussion of the ecology in the area of the Site. The Site ecology is briefly presented below based on these documents and Site-specific information.

The vegetation in the Southeast Idaho Phosphate Resource Area is transitional between the Great Basin vegetation to the south and the Rocky Mountain vegetation to the north (MW, 1999). The six vegetation types within the Southeast Idaho Phosphate Resource Area are a result of elevation, moisture, temperature, soil type, slope, and aspect. Three communities dominate the Site including non-forest lands, forested lands, and less common riparian and wetlands areas. The non-forested land predominates on and around the Site. Forested land (dominantly conifers) is primarily located near the southern end of the Site. The central portion of the ridge bounding the eastern side of the Site is dominantly aspen and scattered aspen are present on most of the leeward slopes. Riparian and wetland areas occur locally near ponds, seeps and springs, and streams including the Little Blackfoot River.

Vegetative cover on the reclaimed areas of the Site is good to excellent with better than 90 percent coverage in most areas. The vegetation consists mainly of grass and forbs species and some areas with a higher concentration of woody species.

Additional information on the soil and vegetation at the Site obtained from surveys conducted in 2009 can be found in Section 2.5.2 above and *Appendix A2* of the *RI/FS Work Plan*. In addition, the chemical data associated with the Site vegetation (including some breakdown by plant type) is presented in Section 4.2 of this document.

Based on previous investigations, the Southeast Idaho Phosphate Resource Area contains or supports about 75 species of mammals, 272 species of birds, 16 species of reptiles, 16 species of fish, and seven species of amphibians (USGS and USFS, 1977; USFWS, 1985 and 1997; and Idaho Conservation Center Data Base 1999, all as cited in MW, 1999). More specifically, the Blackfoot Bridge Mine EIS provides specific discussion of the ecology and animal species that are thought to occur in the immediate area, and those that have been observed in the Blackfoot Bridge project area located approximately four miles south of the Site (BLM, 2011). These include several members of the rodent family such as marmot, various bats, intermediate and large-sized mammalian species such as badgers, deer, elk, and moose, raptors, several migratory birds, reptiles such as garter snakes, and amphibians.

The only threatened and endangered species occurring in Caribou County, in which the Site is located, is the Canada lynx (Lynx canadensis). The Canada lynx is listed as threatened species (USFWS, 2008). To date, the species has not been seen at the Site.

2.8 DEMOGRAPHY AND LAND USE

Farming and ranching are the dominant land uses in the vicinity of the Site, although public recreation is important on the adjacent Federal/State lands. The primary public recreational use is hunting. Mining is the principal use of the area with active mining being conducted by P4, as well as Agrium, in the vicinity of the legacy P4 Sites.

Potential water resource uses in the Site area include industrial use, irrigation, stock watering, recreational use, wildlife use, and cold-water biota use. Groundwater use in the vicinity of the Site is dependent on several variables, including population and land use, availability and quality of surface water, and availability and quality of groundwater. Near the Site, groundwater use generally is limited to livestock watering with some residential domestic wells primarily in the valley east of the Site. Farming consists of dry-land crops that often are not irrigated.

Grazing that occurs on the former State-leased portions of the Henry Mine is between the Idaho Citizens Grazing Association and Idaho Department of Lands.

The area surrounding the Site is sparsely populated. The largest nearby population center is Soda Springs, Idaho, which is located 16 miles to the south-southwest of the Site. The unincorporated community of Henry with a population of less than 100 is located about one mile to the north-northwest of the Site. Outside of these areas, the population largely resides on scattered ranches and farms.

Soda Springs is the largest community in Caribou County and accounts for nearly half of the county population. The 2014 Census (U.S. Census, 2010) counted 3,058 residents. Current census data for Caribou County can be found at the following website.
http://quickfacts.census.gov/qfd/states/16/16029.html

2.9 CULTURAL AND NATURAL RESOURCE FEATURES

Cultural resources are often equated with archaeology, but also include cultural landscapes, historical records, social institutions, expressive cultures, and old buildings. SE Idaho is located within the Snake River and Salmon River culture area of the northern Great Basin (Butler, 1986). The Site is located in the Central Rocky Mountains at the edge of this culture area. As stated in the Blackfoot Bridge EIS (BLM, 2011), the chert and porcellanite facies of the Phosphoria Formation in SE Idaho are not important archeological resources due to the low number of fossils and impurities found in the formation. The rocks were not of adequate quality to be attractive to early area inhabitants for stone tool manufacture. Additional details of the cultural resources, including the prehistoric context of SE Idaho, are documented in the Blackfoot Bridge EIS (BLM, 2011).

In a historic context, the first recorded Euroamericans to arrive in SE Idaho were fur trappers and explorers in the early 1800s. Other immigrants including those traveling through the area to the west coast, Mormon pioneers, and gold miners continued to settle the area in the 1800s. The encroachments of these Euroamerican settlements led to displacement of the native peoples in the area, primarily the Shoshone and Bannock Tribes. The Fort Hall Reservation, north of Pocatello, was established in 1868. The Fort Bridger Treaty established in 1868 was a Peace Treaty between the United States and the Shoshone and Bannock Tribes. Part of the Treaty Rights resulting from the Fort Bridger Treaty was intended to preserve the rights of the Tribes to hunt, fish, gather, and practice other traditional land uses. It was written that these activities were to occur in unoccupied federal lands. Through this, the Shoshone Bannock Tribes continue to gather traditional use plant species and vegetation on unoccupied federal lands. The Federal government has an obligation to consult with the Shoshone and Bannock Tribes on issues that could have a bearing on their traditional use of the land in the area of the Sites or that could impact their Treaty Rights.

2.10 SOURCES OF CONTAMINATION

The constituents of potential concern and potential ecological concern (COPCs/COPECs) are metals and metalloids (e.g., selenium) and radionuclides (e.g., uranium-238 and decay products such as radium-226) that occur naturally in the geologic formations at the Site. Historic mining activities exposed these formations and created constituent-enriched landforms (i.e., waste rock dumps and mine pits). Infiltrating precipitation and snowmelt and erosional forces act to mobilize constituents to downgradient environmental media (soil, sediment, surface water and groundwater). These constituent sources are discussed below. Additional discussion regarding contaminant fate and transport is included in Section 5.0.

2.10.1 Phosphoria Formation

The primary known/recognized source material of contaminants associated with phosphate mining in SE Idaho is the Meade Peak Member of the Phosphoria Formation (see **Table 2-7** for a stratigraphic column). In particular, the waste shale between ore horizons contributes much of the constituent loading. This is in part because the middle or center waste shale (CWS), as it is known, represents a significant portion of the overburden that is stockpiled when the ore is removed, and this shale is enriched with COPCs/COPECs, most notably selenium, but also other elements like cadmium and uranium. Please note that in undisturbed and pre-mined areas, these same enriched constituents contribute to elevated background concentrations of these COPCs/COPECs in soils overlying the Meade Peak Member. However, because of local pedogenetic and geochemical conditions, the actual constituents that are elevated and their concentration may vary spatially in these soils (i.e., more or less enriched depending on location). In addition, naturally elevated background concentrations in the soils overlying the Meade Peak Member can result in elevated concentrations of some elements in soil downslope of Meade Peak outcrops in soil and it is hypothesized that concentrations may be elevated in stream sediment, and possibly downgradient groundwater and surface water (MWH, 2015b). Thinner waste shale beds above and below the ore horizons also contain elevated concentrations of the Site constituents. **Figure 2-10** depicts the relevant portion of stratigraphic section associated with mining activities in SE Idaho along with the average phosphorus content of the ore horizons.

The general lithogeochemistry of the Meade Peak Member is summarized in Herring and Grauch (2004) in which 11 major elements and 21 trace elements are evaluated and discussed. These researchers note that concentrations of cadmium, chromium, selenium, silver, uranium, and zinc are "exceptionally" enriched in the Meade Peak Member compared to the world-wide shale average as shown in **Table 2-10**.

It is specifically noted that the range of mean selenium values for the individual ore and waste shale units (upper, center, and lower waste shale, and upper and lower ore) is 39 to 68 parts per million (ppm; approximately equivalent to milligrams per kilogram dry weight; mg/kg dw), compared to a typical shale average of approximately 0.8 ppm (Herring and Grauch, 2004). Perkins and Piper (2004) also summarized lithogeochemical data from the Meade Peak Member. Their statistical summary is presented in **Table 2-11** for soil COC and other elements of interest. Included in this table for comparison are the background concentrations developed for the RI. It is apparent from this work that the Meade Peak bedrock is enriched in all the soil analytes of interest and that soils formed over the Meade Peak will have some of the highest COC concentrations observed on the Site.

The upper Phosphoria Formation Rex Chert and Cherty Shale lithogeochemistry is presented in Hein, et. al. (2004a), and the document includes a presentation of the geochemistry of these units at the adjacent Enoch Valley Mine. The mean concentrations observed in the Rex Chert and Cherty Shale at Enoch Valley are: 4.37 ppm for arsenic, 18.3 ppm for selenium, 297 ppm for chromium, and 282 ppm for zinc. Cadmium and uranium data are not reported. Also noted is that the higher selenium concentrations are from rocks transitional to the Meade Peak. Without the transitional rocks included in the means, the average selenium concentration is less than 1 ppm. Hein, et. al. also stated that other elements of environmental interest occur at concentrations near or below the shale average.

The leachable elements in the Meade Peak Member were evaluated in Herring (2004) for rocks collected from measured sections at the Enoch Valley Mine (two sections and one core) and two other mines: the Rasmussen Ridge Mine, adjacent to Enoch Valley Mine; and the Dry Valley Mine, southeast of the Henry Mine (one section each). Herring observed that selenium, cadmium, and zinc are most leachable from unweathered rocks. The study indicates that oxidation after excavation from a mine is not needed for the initial release of selenium and other trace elements.

The most relevant data summarizing the elemental enrichments found in the mined units at the Henry Site are summarized above. Some additional data describing elemental concentrations contained within the Meade Peak Member is presented in the *Ballard RI Report*. In addition, P4's sampling of soils overlying the Meade Peak Member is described in the *On-Site and Background Areas Radiological and Soil Investigation Summary Report for P4's Ballard, Henry and Enoch Valley Mines* prepared in 2015 (*Radiological/Background Report;* MWH, 2015b) support the hypothesis that soils formed over the Meade Peak Member of the Phosphoria Formation will have some of the highest COC concentrations observed on sites where it is present.

2.10.2 Waste Rock

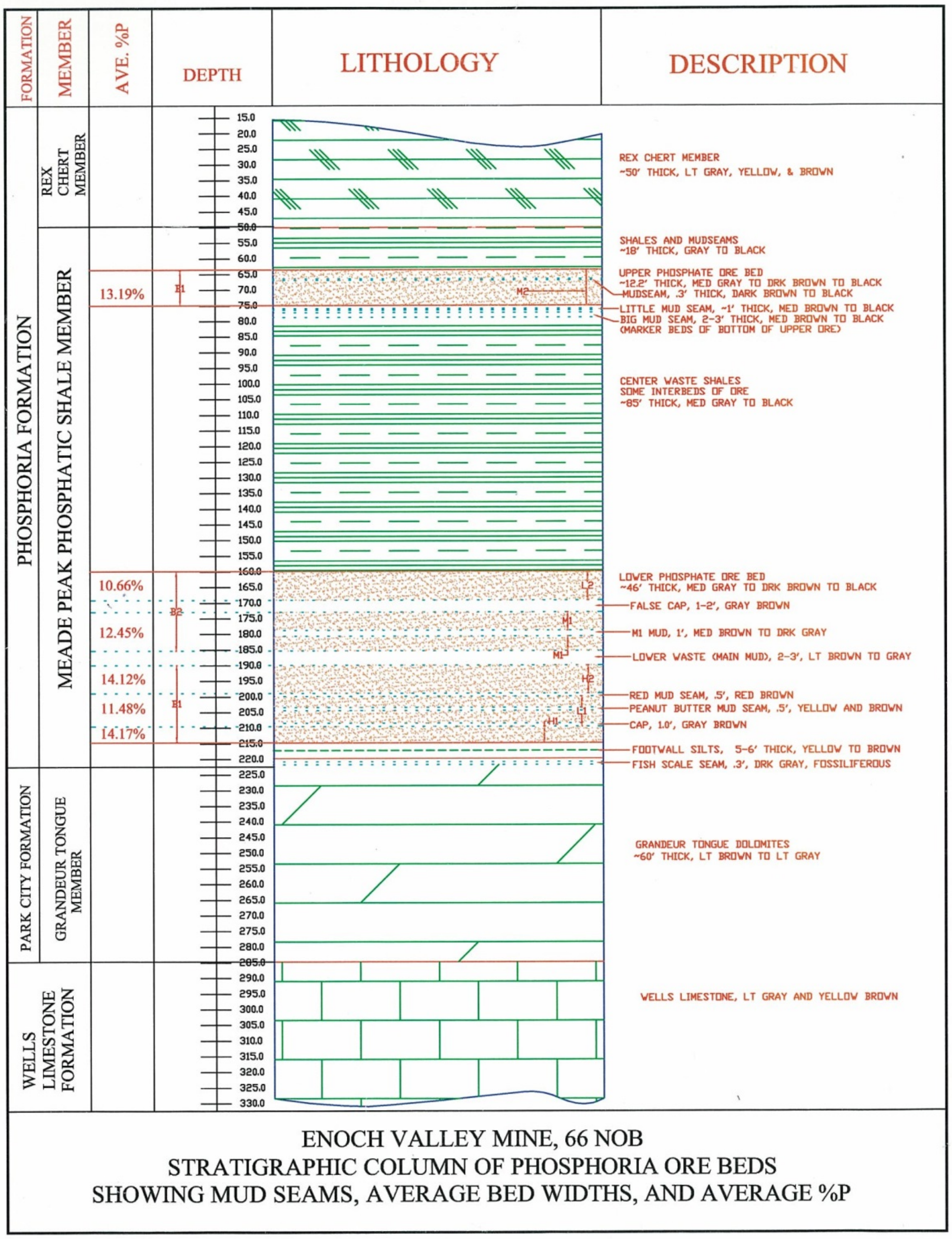
As described in the *Ballard RI Report* there have been several studies conducted at mine areas near the Site that provide data on the character and behavior of waste rock. A study was conducted at the Enoch Valley Site where the waste rock was drilled and various geochemical, hydrological, and physical measurements were collected throughout the waste rock profile (Tetra Tech, 2008). A second useful study was a baseline geochemistry study conducted for the Blackfoot Bridge EIS. The results of this study were reported in Whetstone (2009) and BLM (2011). These studies provide some insight into to the processes that may also be occurring at the Site, and they are summarized extensively in the *Ballard RI Report*.

Key findings that are correlative to the Site and are considered in the conceptual model were:

- The Enoch Valley Site waste rock is net neutralizing on average with no samples characterized as acid generating.
- At the Enoch Valley Site, the total selenium concentrations ranged from 0.79 to 139 mg/kg with leachable selenium ranging from not detected at 0.0001 mg/L to 0.119 mg/L., and sulfur ranged from not detected at less than 0.01% to 2.08%.
- The depleted oxygen and elevated carbon dioxide with increasing depth in the Enoch Valley Site waste rock suggests that microbial decomposition of organic matter is occurring in the pit backfill along with limited air circulation and that sulfide oxidation is probably only occurring within a few feet of the surface. However, even without large amounts of sulfide oxidation, leachable (soluble) selenium is available through the Enoch Valley Site waste rock.

FIGURE 2-10

STRATIGRAPHIC COLUMN OF PHOSPHATE ORE HORIZONS AT THE ENOCH VALLEY MINE



Notes: Ave. % P – Average percent phosphorus

- At Blackfoot Bridge Mine, it was noted that antimony, arsenic, cadmium, chromium, copper, lead, mercury, silver, strontium, and uranium were most concentrated in the ore beds. Nickel, selenium, and zinc were most concentrated in the waste shale. Molybdenum was concentrated in the ore and waste shale.
- Results from the synthetic precipitation leaching procedure (SPLP; EPA Method 1312) on Blackfoot Bridge Mine waste rock indicated that selenium could leach in concentrations exceeding the State of Idaho surface water criterion of 0.005 mg/L.
    - It was found in column studies conducted for the Blackfoot Bridge Mine that with the exception of iron and manganese, which may be more mobile in lower oxygen environments, elements of concern were less mobile in the saturated conditions and more mobile in the unsaturated conditions. This was particularly true for selenium, which was relatively immobile in the saturated conditions (BLM, 2011). Selenium exceeded the State of Idaho surface water quality standard of 0.005 mg/L in all unsaturated column effluents for all cycles; however, for the saturated columns, selenium was exceeded only in the first cycle samples.

While the specific analyte concentrations determined during the Blackfoot Bridge Mine and Enoch Valley Site studies are not directly relevant to the Site, these data help support the overall site conceptual model and the understanding of contaminant mobility and transport in geologic materials similar to the Site. For example, the differences in analyte mobility observed in saturated (oxygen limited) and unsaturated (oxygenated) Blackfoot Bridge Mine columns may help clarify the conceptual model and explain why elevated constituent concentrations are detected or are not detected depending on the hydrogeologic setting.

In addition to the geochemical data collected from waste rock studies, some site-specific non-chemical data have been collected at Enoch Valley Site that are useful for development of the general Site conceptual model. These data were collected during the Tetra Tech (2008) Waste Rock Study, including grain size data, moisture content, and soil moisture characteristic curve results. An extensive summary is presented in the *Ballard RI Report* and is not repeated here. Its importance will be primary for use in the FS and will need to be evaluated for that study. However, one of the key findings was that covers resulted in percolation into the waste rock of only approximately 2 percent of the annual precipitation. Continued cover performance monitoring will provide valuable data related to cover system designs that will be used during the evaluation of alternatives in the FS.

Data from all three sites monitored by O'Kane Consultants (O'Kane, 2009a & b) may be useful in establishing hydrologic characteristics of various cover configurations that occur at the three P4 Sites, including various thicknesses of soil and rock cover. In 2007 and 2009, several site locations were instrumented with a network of moisture sensors (e.g., time domain reflectometry or TDR sensors) including P4's South Rasmussen Mine. Data from this site and the other sites monitored by O'Kane Consultants (O'Kane, 2009a and 2009b) may be useful in establishing hydrologic characteristics of various cover configurations that occur at the three P4 Sites, including various thicknesses of soil and rock cover.

2.10.3 Mine Pits

Specific data have not been collected from the Phosphoria Formation exposed in mine pits to address how readily pit walls release selenium and other analytes. However, the lithogeochemical characterization, discussed in the *RI/FS Work Plan* likely is accurate for release of selenium and other analytes given that the bedrock is exposed in the pit walls. Fundamentally, the rate and mass of constituent release from the exposed pit walls will be lower than for the waste rock dumps. This is because there is much less rock surface area available for leaching in a pit wall compared to a waste rock dump. Any leaching of soluble selenium in the mine pits would occur via similar geochemical processes to the column leach tests such as those conducted for the Blackfoot Bridge Mine (BLM, 2011), and selenium would theoretically decline over time as the soluble fraction is leached.

Selenium release associated with the Site mine pits is likely minimal because the Wells Formation (the footwall bed) is the majority of rock exposed in the mine pits. Small sections of unmined exposed Meade Peak Formation are potentially present in the end of the unbackfilled portion of mine pit (MMP044), and also present in the bottom and east (hanging wall) side of the unbackfilled areas of pits MMP041 and MMP044. However, where exposed in the mine pits, the Meade Peak is often covered by shallow soil and pit wall talus from the overlying beds (i.e., the Rex Chert and Cherty Shale).

3.0 SITE INVESTIGATIONS

The data collected for the Site mostly were obtained as part of the EE/CA SI as described in the *RI/FS Work Plan*. However, some studies were identified in the *RI/FS Work Plan* to address data gaps or other longer-term data needs. The scope and data produced from the EE/CA SI and supplemental RI/FS studies are presented in this section. These data are used in the evaluation of nature and extent of contamination that is presented in Section 4.0.

Table 3-1 outlines the number of samples for various media collected since the 2003 CO/AOC that are relevant to the Site and as part of the RI/FS. **Table 3-2**, summarizes the analytical parameters that have been analyzed for each of the media. Maps depicting the spatial distribution and concentrations of the key constituents throughout the Site are presented in Section 4.0.

3.1 PREVIOUS INVESTIGATIONS

Several studies have been conducted since 1996 at and near the Site to assess the nature and extent of impacts from phosphate mining. These studies are listed chronologically in Section 2.3 of the *RI/FS Work Plan* and a subset of notable investigation and study reports is provided below. Studies conducted from 1996 to 2004 are included for historical context with the recognition that older data, and data collected at other P4 and regional phosphate mining sites, may provide insight into fate and transport behavior of constituents at the Site.

1998-2001

- *Regional Investigation Data Summary Reports* (MW, 1998-2001b)

2002

- *Area Wide Investigation Data Summary Reports* (MWH, 2002a and 2002b)
- *Final Area Wide Human Health and Ecological Risk Assessment, Selenium Project, Southeast Idaho Phosphate Mining Resource Area* (Tetra Tech, 2002)

2004

- *Area Wide Risk Management Plan: Removal Action Goals and Objectives, and Action Levels for Addressing Releases and Impacts from Historic Phosphate Mining Operations in Southeast Idaho* (IDEQ, 2004a)

2007

- *Interim Phase I SI Evaluation Summary Report, Draft* (MWH, 2007)

2008

- *Interim Report for Hydrogeologic Investigation Revision 3 – 2007 Hydrogeologic Data Collection Activities & Updated Conceptual Models* (MWH, 2008)

2010

- *Data Quality and Usability Report (DQUR) and Data Approval Request (DAR) – Final, Revision 2* (MWH, 2010)

2011

- *Remedial Investigation/Feasibility Study Work Plan for P4's Ballard, Henry and Enoch Valley Mines. (*MWH, 2011)

The evaluation of the 2004 to 2009 EE/CA SI data in the *RI/FS Work Plan* identified data gaps that were fulfilled through supplemental studies. These supplemental RI investigations and the year(s) they were conducted are listed below:

- Ongoing surface water and groundwater monitoring (2010 - 2014)
- Sediment, riparian soil, and surface water sampling (2010)
- Direct-push borehole installation (2010)
- Background levels development (2013 and 2015)
- On-Site and Background Areas radiological and soil investigations (2015)

These RI/FS supplemental studies are documented in the 2010 - 2014 Data Summary Reports (DSRs) in addition to the several reports and technical memorandums listed below.

2013

- *Ballard, Henry, and Enoch Valley Mine, Remedial Investigation and Feasibility Study, Background Levels Development Technical Memorandum* (*Background Levels Tech Memo*; MWH, 2013a)

- *2010 and 2012 DSR Ballard, Enoch Valley, and Henry Mines Remedial Investigation Activities* (MWH, 2013b)

2014

- *2013 DSR Ballard, Enoch Valley, and Henry Mines Remedial Investigation Activities* (MWH, 2014a)

- *Remedial Investigation Report for P4's Ballard Mine* (*Ballard Mine RI Report*; MWH, 2014b)

2015

- *2014 DSR Ballard, Enoch Valley, and Henry Mines Remedial Investigation Activities* (MWH, 2015a)

- *Radiological/Background Report* (MWH, 2015b)

3.2 SURFACE/MINE FEATURES

Physical characterization of the Site was conducted during the EE/CA SI. Digital topography for the existing Site was obtained from high resolution aerial mapping conducted for P4 in 2008. These data were compared to digital pre-mine topography from the USGS. A computer program used these two topographic surfaces to perform a cut-and-fill analysis as discussed in Section 2.1 to obtain the extent and volumes of the mine features focusing largely on the mine waste rock accumulations. The topographic information and extent of mine features were then verified with the high resolution orthophotography obtained by P4 and with on-the-ground surveys, including data relating to mass wasting, soil cover, and other physical attributes from activities conducted in 2004 and 2008 (MWH, 2004 and MWH, 2009b). Other sources of data relating to the physical characterization of the Site area are P4 records, including a large set of hardcopy mine maps. The remaining information collected for the physical characterization of the mine area was obtained by direct physical observation during the numerous field activities, and by researching public records.

3.3 UPLAND SOIL/WASTE ROCK AND VEGETATION INVESTIGATIONS

Upland soil/waste rock and vegetation samples were collected from the Site during studies in 2004, 2009, and 2014 as summarized on **Tables 3-1** and **3-2**. These studies addressed soil and vegetation in upland areas on mine waste dumps, mine pits, native ground, and other ancillary areas including haul roads. The locations of the upland soil/waste rock and vegetation samples are shown on **Drawing 3-1.** These data provide the basis of the nature and extent discussion presented in Section 4.1.

3.4 RIPARIAN SOILS, VEGETATION, AND SEDIMENT INVESTIGATIONS

Sediment, riparian soils, and riparian vegetation samples were collected from the Site in 2004 and 2010. These sample locations coincide with and are a subset of the surface water locations mentioned in Section 3.5 (at stream locations, springs, dump seeps, and ponds). The surface water/riparian sample locations are described in **Tables 3-1**, **3-2**, and **3-3**, are shown on **Drawing 3-2**, and results are presented in Sections 4.2 and 4.3.

3.5 SURFACE WATER INVESTIGATIONS

Surface water investigations between 2004 and 2014 have utilized 30 designated sampling locations in areas in, near or downstream of the Site. The surface water locations include stream locations (including on the Little Blackfoot River), springs, dump seeps, and ponds. These locations are presented on **Drawing 3-2** and the investigations are summarized in **Tables 3-1**, **3-2**, and **3-3**. A photographic log showing the stations is provided in **Appendix C**. Results and evaluations of surface water sampling data are presented in Section 4.4.

3.6 GROUNDWATER INVESTIGATIONS

The groundwater investigations included identifying and obtaining available mine maps, cross-sections and exploration logs, and the locations and logs for domestic, agricultural, industrial, and monitoring wells within a three-mile radius of the Site. These data were used to help develop conceptual models and identify flow paths for investigation. The flow paths investigated were those thought to most likely be affected by releases from the potential sources (i.e., waste rock and mine pits). Groundwater sampling and monitoring data were used to evaluate the movement of contaminants in the three primary groundwater systems identified in Section 2.6.

Groundwater monitoring wells were installed for collection of groundwater samples in 2007 and 2008 in support of the EE/CA hydrogeologic characterization. Several existing wells were sampled as early as 2004, of which only three were used for EE/CA sampling at the Site. Direct push borehole sampling events were conducted in 2009 and 2010, to collect grab (one-time) groundwater samples. One permanent direct-push monitoring well was installed during the 2009 direct push event.

Excluding the direct push investigations, collection of groundwater samples from Site monitoring wells between 2004 and 2014 has been on a semi-annual to annual basis for all of the groundwater monitoring locations depicted on **Drawing 3-3**. The locations of the wells and boreholes sampled as part of the groundwater investigation and one-time direct-push sampling are shown on **Drawing 3-3** and summarized on **Tables 3-4, 3-5** and **3-6**. Results and evaluations of groundwater sampling data are presented in Section 4.5.

Agricultural and domestic wells are shown on **Table 3-4** and **Drawing 2-1**. These wells were assigned to the background data set, which are presented and discussed in MWH, 2013a. The background data set as it relates to the Henry Site is summarized in Section 4.5.

3.6.1 Supplemental Groundwater Analyses

A selenium study was conducted at the Site as part of the *Selenium Speciation Study in Ground Water at Ballard and Henry Mines* (MWH, 2006), which included the sampling and laboratory analysis procedures and the results. Groundwater samples were collected from Ballard and Henry Site wells and analyzed to determine the selenium species in the samples. Two Henry Site wells, MMW004 and MPW022, were sampled in November 2005 and the findings of this study are summarized in Section 4.5.

3.6.2 Aquifer Solids Sampling

Five rock chip samples were collected from well boreholes as part of monitoring well installation between July and September 2007. The samples were analyzed for chemical parameters and COPCs, and the data are presented in Section 4.5.5. These data are useful for evaluating the effects the aquifer may have on the water quality.

3.7 ECOLOGICAL INVESTIGATIONS

A variety of biological-chemical data (elk tissue, bird egg, and a cattle study) are available from the pre-2003 CO/AOC period, but these data were not validated to current standards. However, the A/T and P4 have agreed that sufficient data and information are available so that the data could be validated to current standards, should a need be identified for quantitative use of the data to support the BRA. The cattle data in particular are relevant as they were collected from cattle grazed on a Henry Site waste rock dump, and the study included data for associated cattle tissues, vegetation and soils as discussed below in Section 4.6.3. These pre-2003 data and associated data quality evaluations are detailed in the *Data Quality and Usability Report* (*DQUR*, MWH, 2010) and summarized in the *RI/FS Work Plan*.

Additional pre-2003 CO/AOC biological and chemical data exist that may not be able to be validated to current standards. For example, limited small mammal sampling was conducted in waste rock areas of the Site in 2001. If, following the risk assessment, the need to sample small mammals is under consideration, then the pre-2004 biological data may be useful for comparative purposes to refine the data requirements or for developing a scope. As discussed in Section 6.0, these pre-2004 data are not used to calculate potential impacts to biologic receptors in the BRA presented in this *RI Report*. However, validated data are available from 2004 for other ecological receptors, including various aquatic invertebrates and fish. Past ecological investigations in support of the RI are listed and discussed below.

3.7.1 Habitat Assessment and Function Use Surveys

In 2004, P4 conducted aquatic and terrestrial (riparian) habitat assessments. In addition, in 2004, P4 and the A/Ts performed functional use inspections of the non-regulated surface water features (i.e., ponds) at the Site (IDEQ, 2004b). These assessments are summarized in Section 4.4.2.

3.7.2 Aquatic Biota

Benthic macroinvertebrate samples were collected in June 2004 at 17 stations at the Site. Forage fish/salmonids were collected in May 2004 from three stations along the Little Blackfoot River. These data were reported in the *Interim Phase I SIs Evaluation Summary* (MWH, 2007) and are summarized in Section 4.6

3.7.3 Terrestrial Biota

No terrestrial biota data were collected during the post-2003 EE/CA project. However, some data from prior to the EE/CA project may be of use to the RI as discussed above. Twenty (20) cattle were studied in 1999 at the Henry Site. The study took place on cattle grazing areas at reclaimed overburden dumps at the Henry Site and in a background area. Items sampled during the grazing portion of the study included soil and vegetation in the pasture areas, blood and blood serum collected from the cattle. This initial onsite investigation of soil and vegetation was followed by a study of the cattle after they were removed from the grazing area and moved to a feedlot. Samples included blood, muscle and organ tissue. The sampling protocol and resulting tissue data for the feedlot portion of the study are both presented in the *1999 Interim Investigation Data Report* (MW, 2000). These data are summarized in the *RI/FS Work Plan* and are presented in the *DQUR*. As discussed above, these data currently can be used qualitatively in the BRA and can be validated to current standards, if needed.

4.0 NATURE AND EXTENT OF CONTAMINATION

This section presents the nature and extent of contamination detected in the various media that have been sampled at the Site. Several media were analyzed for various constituents of potential concern during the RI studies as summarized in Section 3.0. This section focuses on only those constituents in each medium that exceed relevant regulatory standards and/or drive risks.

In order to determine the constituents that are of concern for the Site, the results of the BRA presented in **Appendix A** (and summarized in Section 6.0) identifies preliminary contaminants of concern and contaminants of ecological concern (preliminary COCs/COECs) that drive human health and ecological risks in each of the media (**Tables 6-27**, **6-29** and **6-30**). For surface water and groundwater, additional preliminary COCs/COECs were added to the list of preliminary COCs/COECs when concentrations of a constituent exceeded its promulgated federal (e.g., MCLs in groundwater) and state chemical-specific standards/criteria. Because promulgated chemical-specific standards for soil, sediment, and vegetation do not exist, this RI relies on comparison of these data to background levels developed during the RI. No risk-based preliminary COECs for livestock were identified in the LRA; preliminary COCs/COECs derived from comparison to regulatory standards and comparison to background levels are assumed to be protective of livestock.

To summarize, the preliminary COCs/COECs discussed herein are selected because they:

1. Are associated with risk or hazard estimates that exceed acceptable human health and/or ecological criteria – all media.
2. Exceed regulatory benchmarks – surface water and groundwater.

These preliminary COCs/COECs, then are refined by evaluating their Site-specific spatial and temporal concentration trends.

For each medium, further refinement of the list of preliminary COCs/COECs is based on evaluating the spatial and temporal trends (e.g., an anomalous one-time exceedance of regulatory standards or at a single sample location may result in the constituent not being considered a preliminary COC/COEC). In addition, certain exceedances may be typical of background conditions as indicated by comparison against background levels or based on the distribution on and near the Site (e.g., elevated concentrations occurring in primarily otherwise unimpacted locations).

The media discussed in this section are in the following order: Upland Soil/Waste Rock (Section 4.1), Upland and Riparian Vegetation (Section 4.2), Riparian Soil and Sediment (Section 4.3), Surface Water (Section 4.4), Groundwater (Section 4.5), and Biota (Section 4.6). In each of these sections, historical data are presented in complete data tables referenced in the text and found in **Appendix B**. These data are compared to A/T-approved background levels for solid media, and surface water and groundwater criteria. The discussions are aided through the use of tables, figures, and drawings.

4.1 UPLAND SOIL/WASTE ROCK

The term "upland soil" is generally used and includes cover soil, native soil, waste rock, and haul road materials present at the Site. The term is basically used for all loose geologic media present on the surface of the Site. Samples of Site upland soil/waste rock were collected during 2004, 2009, and 2014 investigations, and the results for each of these investigations are discussed within this section. These results have been summarized in various RI documents such as the *Supplemental Soil and Vegetation Characterization Data Summary Technical Memorandum* included in Appendix A2 of the *RI/FS Work Plan* and the *Radiological/Background Report*. The *Radiological/Background Report* includes detailed discussions of the re-calculation of upland soil background levels. The 2014 background investigation was performed to fill in data gaps in the previous background data set (e.g., there was no background data from the soil overlying Phosphoria Formation and notably the Meade Peak Member). The updated soil background levels are used in this *RI Report* including the BRA. Complete upland soil/waste rock results compared to the revised background levels are presented in **Appendix B**, **Tables B-1a** and **B-1b**. Sample locations for co-located upland soil/waste rock and vegetation are presented on **Drawing 4-1** and upland vegetation is further discussed in Section 4.2. Summaries of upland soil/waste rock concentrations are provided on **Drawings 4-1** through **4-4** as further discussed in the subsections below.

4.1.1 Preliminary Contaminants in Site Upland Soil/Waste Rock

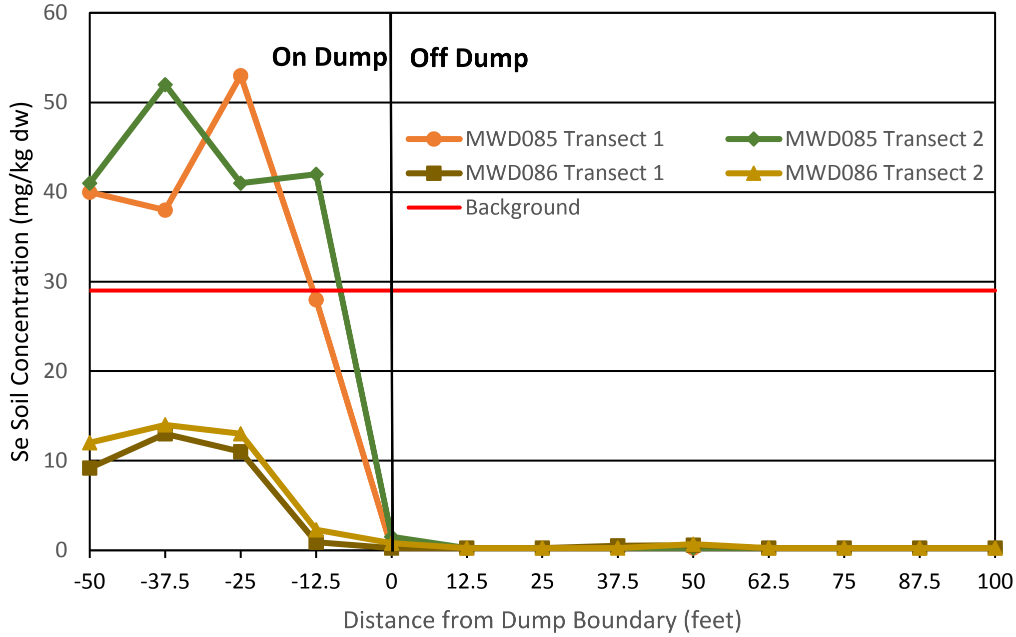
To facilitate this discussion, this section focuses on upland soil/waste rock constituents that are identified as preliminary COCs/COECs from direct and indirect exposure pathways detailed in the BRA (see Section 6.0). Based on the BRA, arsenic, cadmium, chromium, copper, molybdenum, nickel, selenium, radium-226, radon-222, thallium, vanadium, and zinc are identified as preliminary COCs/COECs for upland soil/waste rock. The identified preliminary COCs/COECs are further compared to background values in the evaluations presented below.

4.1.2 2004 Waste Rock Dump Mass Wasting Soil Investigation

A reconnaissance of mine waste rock dumps (MWD) at the Site was performed in June 2004 to identify and map existing and potential mass-wasting areas along dump boundaries. One location with potentially impacted off-dump soil, on and just off of MWD086, and one control area, MWD085, were selected for sampling. The control area at MWD085 was selected because the off-dump portion is located uphill of the actual waste rock dump, thus allowing for little or no potential for off-dump transport of soil/waste rock on to this area. Two parallel downward sloping, 150-foot transects, 12.5 feet apart, were set up beginning on-dump and crossing the dump boundary onto undisturbed (native) land surface for both MWD085 and MWD086. Thirteen (13) co-located soil (0 to 2 inches bgs) and vegetation samples were collected along each of the four transects (total of 52 samples) and were analyzed for selenium only. Transect locations and selenium sampling results are presented on **Drawing 4-1** for soil. The co-located vegetation selenium results are also shown on **Drawing 4-1** and are discussed in Section 4.2.1.

Figure 4-1 presents line plots of the soil results along each transect. The upland soil selenium background level of 29.0 mg/kg is plotted on the graph. The highest selenium concentrations are reported from samples collected on the waste rock dumps, and concentrations decrease rapidly with distance along each transect. Selenium concentrations from soil/waste rock collected on the mine dump along the MWD085 transects (including the off-dump control area) range from 28 to 53 mg/kg and decrease to the detection limit (0.5 mg/kg) immediately off the waste rock dump. All of the upland soil/waste rock selenium concentrations along the MWD086 transects are below the background level. Selenium concentrations on MWD086 range from 0.9 to 14 mg/kg and range from <0.5 to 0.8 mg/kg off the waste rock dump.

FIGURE 4-1
MWD085 AND MWD086 TRANSECTS 1 AND 2 - SELENIUM IN UPLAND SOIL/WASTE ROCK



4.1.3 2009 Upland Soil/Waste Rock Dump and Facility Characterization

In June 2009, a soil survey and surface soil sampling was conducted at the potential Site source areas (five waste rock dumps/partially backfilled pits and one historic haul road) and a mine-specific background area located adjacent to the mine area. The primary objective was to characterize the nature and extent of constituents within the mine area boundaries. A total of 70 five-point composite surface soil samples (10 from each source area and background area) were collected from 0 to 6 inches bgs and analyzed for a suite of 18 metals and metalloids. Complete data are provided in **Appendix B**, **Table B-1a** and soil sample locations are shown on **Drawing 4-1**.

A summary of preliminary COC/COEC concentration ranges for each potential source area are included in **Table 4-1** and are compared to background levels. Arsenic, cadmium, selenium, and thallium are presented on **Drawing 4-2** and are further discussed below. These preliminary risk-based COCs/COECs are selected from those listed in **Table 4-1** based on the number of exceedances above background levels and the fact that they are found in other downstream media such as surface water and groundwater. Note that radium-226 data also is included on **Drawing 4-2** and these data are further discussed in Section 4.1.4.

Arsenic concentrations in upland soil/waste rock collected across the waste rock dumps and haul road ranged from 4.0 to 45.5 mg/kg (**Table 4-1**). As shown on **Drawing 4-2**, all of the waste rock dump areas and the haul road have samples that exceed the P4 Sites arsenic background level of 15.6 mg/kg (yellow and blue sample locations). Waste rock dump MWD086 and portions of the haul road that traverse across the dump have a greater percentage of soil sample locations that are below the background level (green sample locations). Whereas, arsenic concentrations from all ten samples collected from MWD087 are above the background level. The highest arsenic concentrations from soil samples collected across the source areas range from 32.1 mg/kg (MWD087) to 45.5 mg/kg (MHR002 – haul road).

Unlike arsenic concentrations, a majority of the upland soil/waste rock samples have cadmium concentrations below the background level of 41.0 mg/kg (**Drawing 4-2**). Cadmium concentrations across the waste rock dumps and haul road range from 2.1 to 59.5 mg/kg as summarized on **Table 4-1**. An area within MWD085 includes four samples that exceed the background level, but the concentrations range from 42.2 to 46.6 mg/kg, which is slightly (approximately 10 percent) above the background level. Other exceedances of the background levels are in isolated locations within each of the waste rock dumps.

The range of thallium concentrations in upland soil/waste rock are 0.171 to 2.31 mg/kg compared to a background level of 1.1 mg/kg. Similar to arsenic and selenium, exceedances of the background level occur on each of the waste rock dumps and along the haul road (**Drawing 4-2**). However, as seen on **Table 4-1**, most of concentrations are within about two times the background level.

Selenium concentrations from upland soil/waste rock samples collected across the waste rock dumps and haul road range from <0.5 to 318 mg/kg. As shown on **Drawing 4-2**, exceedances of the background level (29.0 mg/kg) occur on each of these areas and are similar in pattern of exceedances to arsenic. However, large areas of MWD086, MWD088, and MHR002 (haul road) have selenium levels that are below background. The highest selenium concentrations are reported in samples collected from MWD090. Eight of the 10 upland soil/waste rock samples collected from MWD090 have selenium concentrations above the background level and range from 31.0 to 318 mg/kg.

4.1.4 2014 Upland Soil/Waste Rock Radiological Characterization

During development of the *RI/FS Work Plan* and *Ballard Site BRA*, it was determined that specific radiological data was lacking for the P4 Sites and from background areas, and the *Ballard BRA* (MWH, 2014b) had to rely on a number of assumptions to estimate radiological risk. Also, the existing upland soil background dataset was not inclusive of all geologic formations represented at the P4 Sites (i.e., lacked background data from the Phosphoria Formation). As a result, in 2014, an investigation was conducted to collect radiological data (gamma and radon measurements) from the P4 Sites and background areas. These data were used to directly calculate Site-specific upland soil background levels and the Site radiological risks as described in Section 6.0. A summary of the radiological field measurements from the Site are presented herein with the complete details provided in the *Radiological/Background Report*.

4.1.4.1 Gamma Survey

Across the waste rock dumps, partially backfilled pits, and haul road, a gamma survey was performed along transects spaced at approximately every 200 feet and along the perimeter of the source areas at the Site. The primary objective of the gamma surveys was to provide data, which when combined with the results of the correlation studies, could be used to predict radium-226 concentrations in Site-wide upland soil/waste rock for use in radiological risk assessment evaluations for a hypothetical future human receptor.

Observed gamma count rates were used to estimate the lateral extent of waste rock dump contamination and to identify areas of low, medium, and high gamma count rates for correlation and radon flux measurements. A total of 124,686 individual gamma counts measurements were collected across the Site as presented on **Drawing 4-3** and range from 6,086 to 104,798 counts per minute (cpm) with a mean, median, and standard deviation of 27,706 cpm, 27,500 cpm, and 13,005 cpm, respectively.

A correlation study and regression analysis was performed to develop a correlation between gamma count rates and radium-226 in upland soil/waste rock using data collected from the three P4 Sites and the background areas. Three of the 20 correlation samples were collected from the Henry Site as shown on **Drawing 4-3** and these data are provided in **Appendix B**, **Table B-1b**. The resulting correlation from all the correlation sample locations collected from the three P4 Sites (10 samples total) and two background areas (10 samples total) resulted in the following equation to convert surveyed gamma count rates to predicted radium-226 concentrations.

- Ra-226 (pCi/g) = 0.0006 x Gamma Count Rate (cpm) - 4.1

Using the developed correlation, predicted radium-226 concentrations at the Site range from 0.4 to 58.8 picoCuries per gram (pCi/g) with a mean, median, and standard deviation of 12.5, 12.4, and 7.8 pCi/g, respectively. These predicted radium-226 concentration (**Drawing 4-2**) are utilized in the BRA presented in **Appendix A** and as summarized in Section 6.0.

As seen on **Drawing 4-2**, predicted radium-226 concentrations above the background level of 15.1 pCi/g primarily are confined to the waste rock dumps and backfilled pits with the exception of the haul road extending throughout the mine (e.g., southeast of MWD085). A majority of the predicted radium-226 concentrations across the mine are between 15 and 25 pCi/g with the highest concentrations (50 to 80 pCi/g) located across MWD090 and the haul road that continues to the east of this dump.

4.1.4.2 Radon Flux Survey

A radon (radon-222) flux survey was also conducted across the P4 Sites and in the two selected background areas. A total of 15 random radon flux measurements were collected at the Henry Site over an area of approximately 21 acres in size as shown on **Drawing 4-4**. The radon flux area targeted at the Henry Site was representative of a "medium" range of gamma counts compared to the Ballard Site (high range) and Enoch Valley Site (low range). The radon flux measurements at the Henry Site range from 2.01 to 9.10 picoCuries per square meter second (pCi/m^2-s). Radon fluxes at the Henry Site (mean of 4.04 pCi/m^2-s) exceed those at Ballard Site (mean of 3.76 pCi/m^2-s), even though the gamma count rates at the former were lower. Radon flux rates likely are higher at Henry Site because the brown shale material used to cover the waste rock (e.g., center waste shales) visually appears to be more pulverized, thereby providing more surface area for radon emanation.

Using a standard equation described in the *Background/Radiological Report*, the radon flux measurements were converted to indoor air concentrations as reported in **Table 4-2** and range from 1.98 to 13.33 picoCuries per liter (pCi/L). For comparison, background radon flux measurements and calculated indoor air concentrations range from -0.4 to 8.62 pCi/m^2-s and -0.58 to 12.7 pCi/L, respectively. The Site and background radon concentrations are used in the BRA (**Appendix A** and Section 6.0).

4.2 VEGETATION

This section presents the nature and extent of preliminary COC/COECs in upland and riparian vegetation at the Site. Site upland vegetation was investigated in 2004 and 2009, and riparian vegetation was investigated in 2004 as summarized below. Results for these investigations are presented in detail in various RI documents such as the *Supplemental Soil and Vegetation Characterization Data Summary Technical Memorandum* included in Appendix A2 of the *RI/FS Work Plan*, and complete results are presented in **Appendix B**, **Tables B-2** and **B-3**. Station locations for both upland and riparian vegetation are presented on **Drawings 4-1** and **4-6**. Summaries of preliminary COC/COEC concentrations are provided on **Drawings 4-1**, **4-5**, and **4-6** and are further discussed below.

4.2.1 Preliminary Contaminants in Site Vegetation

To facilitate the summation, this section focuses on constituents that are identified to be preliminary COCs/COECs for indirect exposure pathways detailed in the BRA (see Section 6.0). Both consumption of upland and riparian culturally significant (CS) plants as well as fruits and vegetables grown in upland soil/waste rock and irrigated with groundwater are considered in the BRA; consumption of upland and riparian plants is included in the chemical uptake for herbivorous and omnivorous ecological receptors in the BRA.

Based on the BRA, arsenic, cadmium, molybdenum, radium-226 (modeled from uranium), selenium, and thallium are further discussed below as preliminary COCs/COECs for *upland* vegetation. Selenium is the only preliminary COC/COEC measured in CS *riparian* vegetation that is associated with unacceptable risk. It is further discussed below in Section 4.2.6 for riparian vegetation. Vanadium is a preliminary COC for CS riparian vegetation based on modeled concentrations in riparian soil. As it was not measured in riparian vegetation, it is discussed in Section 4.3 for riparian soil.

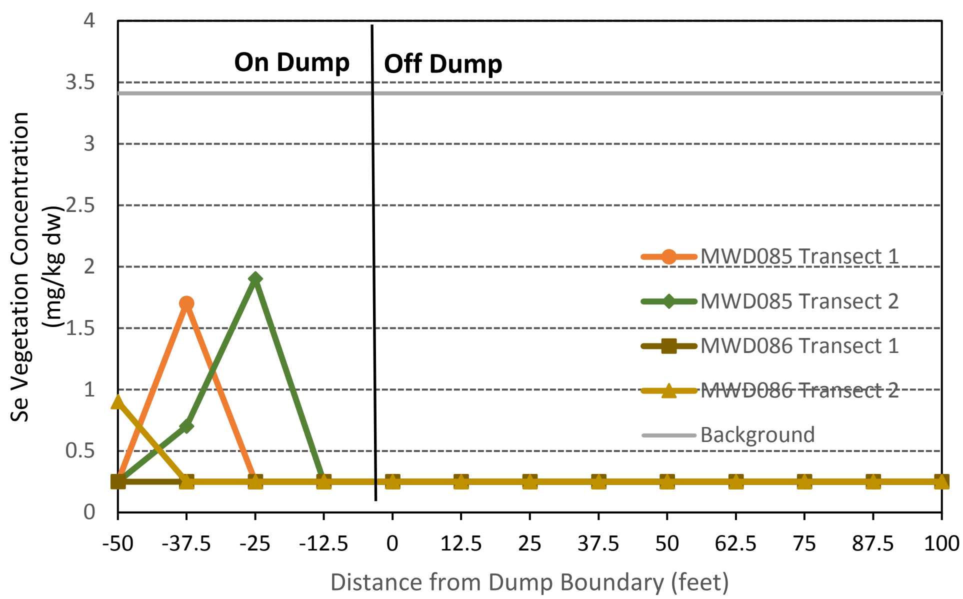
The identified preliminary COCs/COECs are further compared to background levels as presented in the *Ballard FS Memo #1*.

4.2.2 2004 Waste Rock Dump Mass Wasting Vegetation Investigation

Fifty-two (52) co-located soil and vegetation samples were collected along each of the two transects on waste rock dump MWD085 and two transects on waste rock dump MWD086 (described in more detail in Section 4.1.2). These vegetation samples were analyzed for the selenium only and were reported as dry weight. Transect locations and selenium sampling results are shown on **Drawing 4-1** for soil and vegetation. **Figure 4-2** presents line plots of the vegetation results along each transect. The upland vegetation selenium background level of 3.4 mg/kg is plotted on the graph.

All upland vegetation concentrations are below the background values. The highest selenium concentrations were collected on the waste rock dumps and concentrations decrease rapidly to below the detection limit (0.50 mg/kg) with distance along the transect (off-dump). Only three of the 26 total vegetation samples along MWD085 transects have detectable selenium concentrations (0.7 to 1.9 mg/kg). Only one of 26 samples contained selenium (0.9 mg/kg) above the detection limit along the MWD086 transects.

FIGURE 4-2
MWD085 AND MWD086 TRANSECTS 1 AND 2 - SELENIUM IN VEGETATION



4.2.3 2009 Upland Vegetation Waste Rock Dump and Haul Road Characterization

In June 2009, a vegetation survey and sampling program were conducted on the five waste rock dumps and historic haul road. In addition, a mine-specific background area, located adjacent to the mine footprint, was sampled. The survey and sampling results are reported in *Supplemental Soil and Vegetation Characterization Data Summary Technical Memorandum* included in Appendix A2 of the *RI/FS Work Plan*. A summary of the survey is provided in Section 2.5.2, and results of the sampling activities are summarized in this section.

Vegetation sampling was conducted following the vegetation survey discussed above. **Drawing 4-1** shows the identified sample locations while **Drawing 4-5** presents ranges of several preliminary COC/COEC concentrations. A total of 170 vegetation samples were collected from the Site.

The majority of the vegetation samples were composites of grasses and forbs collected from five random one-foot by one-foot grid points within each 50-foot by 50-foot quadrat. Samples of vegetation separated by life form (grasses, forbs, and shrubs), and where available, plants classified as culturally significant, were also collected at some locations.

Table 4-3 presents the preliminary COC/COEC concentrations for the various species of grasses and forbs sampled compared to background levels and complete data are included in **Appendix B, Table B-2**.

Arsenic concentrations in upland vegetation collected across the waste rock dumps and haul road range from <0.0697 to 1.53 mg/kg, as summarized in **Table 4-3**. The maximum arsenic concentrations in individual Site source area upland vegetation range from 0.248 mg/kg on waste rock dump MWD085 to 1.53 mg/kg along the haul road MHR002. No background level was calculated for arsenic.

Similar to upland soil/waste rock (**Drawing 4-2**), the majority of the upland vegetation samples across the source areas have cadmium concentrations below the background level of 1.7 mg/kg (**Drawing 4-5**) and range from 0.254 to 5.29 mg/kg (**Table 4-3**). Exceedances of the upland vegetation cadmium background level are observed in isolated samples within each of the waste rock dumps except for MWD086, which reports a maximum cadmium concentration (1.66 mg/kg), which is below the background level. The highest cadmium concentrations from upland vegetation samples collected across the other five waste rock dumps and haul road ranges from 2.61 mg/kg (MWD090) to 5.29 mg/kg (MWD087).

Molybdenum concentrations in upland vegetation across the Site ranges from <1.46 to 125 mg/kg compared to a background level of 5.78 mg/kg (**Table 4-3**). Waste rock dump MWD087 has the most exceedances of the background level (yellow and blue sample locations on **Drawing 4-5**) with all but two of the upland vegetation samples exceeding the background level with a maximum molybdenum concentration of 125 mg/kg. The maximum molybdenum concentrations across the other source areas range from 13.3 (MWD086) to 58.4 mg/kg (MWD085).

Selenium concentrations in upland vegetation samples range from 0.451 to 146 mg/kg (**Table 4-3**). As shown on **Drawing 4-5**, vegetation samples collected from each of the waste rock source areas exceed the selenium background level of 3.41 mg/kg. However, large areas of waste rock dumps MWD086, MWD087, and MWD088 report selenium concentrations in upland vegetation that are below the background level (green sample locations). Only one vegetation sample location within MWD087 exceeds the selenium background level (blue sample location). However, that selenium concentration is the highest reported across the mine at a selenium concentration of 146 mg/kg. Waste rock dump MWD090 has the most upland vegetation sample exceedances above the background level with selenium concentrations that range from 1.15 to 139 mg/kg.

Thallium concentrations in upland vegetation exceed the background level of 0.016 mg/kg in a majority of the samples (as shown on **Drawing 4-5**, yellow and blue sample locations). The range of thallium concentrations in upland vegetation samples collected from the waste rock dumps and haul road are <0.1 to 0.713 mg/kg while the range of maximum thallium concentrations for the individual source areas are 0.235 mg/kg (MWD086) to 0.713 mg/kg (MWD087).

Uranium is not depicted on **Drawing 4-5,** but it is a used as an indicator for radium-226 risks in upland vegetation that are modeled from upland soil/waste rock as discussed in Section 6.0. Uranium concentrations range from <0.0924 to 1.27 mg/kg in the data set compared to a background level of 0.162 mg/kg (**Table 4-3)**. Uranium concentrations are below the uranium detection limit in the upland vegetation samples collected from waste rock dumps MWD085, MWD086, and MWD090. Vegetation samples collected from along the haul road MHR002 (0.173 mg/kg) have the maximum detection of uranium. Uranium (0.207 mg/kg) detected in vegetation at MWD087 is 25 percent above the background level. As shown in **Appendix B**, **Table B-2,** these are isolated exceedances. The maximum uranium concentration of 1.27 mg/kg is from a sample collected on MWD088, and this is the only detected uranium concentration from ten upland vegetation samples collected from this waste rock dump.

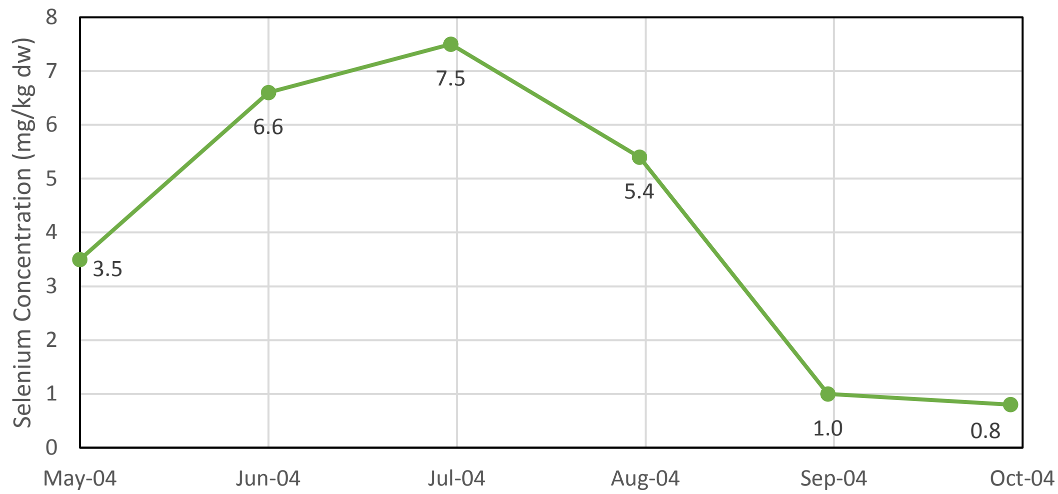
4.2.4 2004 and 2009 Upland Vegetation - Seasonal Investigation

Beyond the concentration of constituents in the vegetation, the 2004 and 2009 sampling programs also addressed the potential of seasonal variations in constituents and their concentrations throughout the Site. Data are provided in **Appendix B**, **Table B-2.**

A combination of new and old growth of grasses and alfalfa were sampled monthly for six months in 2004 (May to October 2004) from one waste rock dump location (MWD086) and analyzed for selenium.

The location is shown on **Drawing 4-1**. The vegetation samples exhibit some monthly selenium concentration variability with an apparent decreasing trend late in the summer and into fall as shown on **Figure 4-3**.

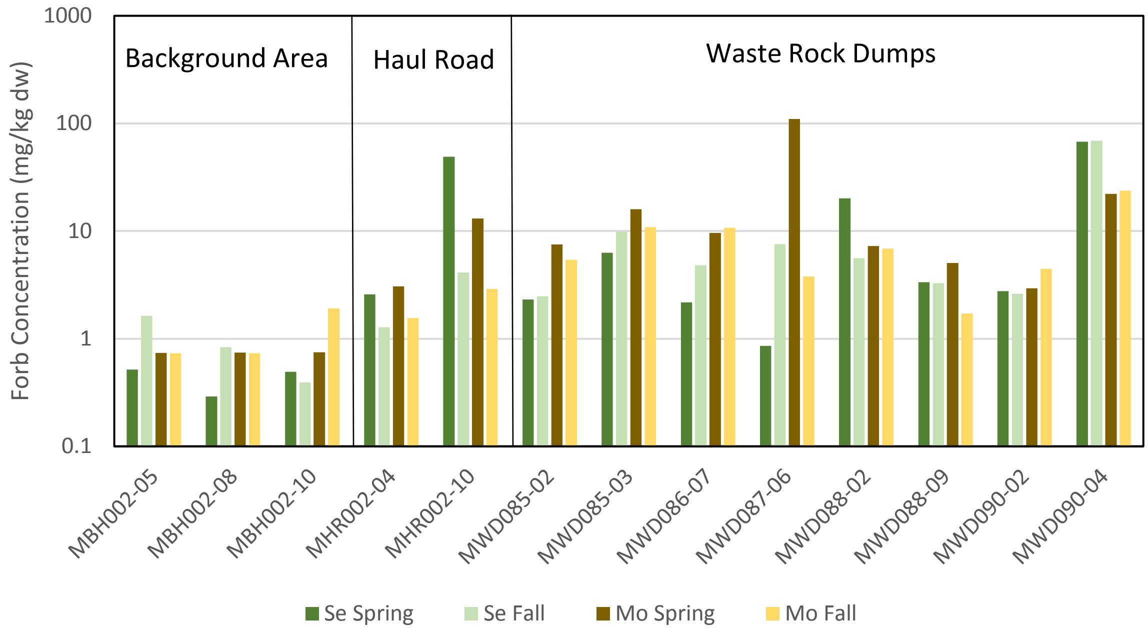
FIGURE 4-3
2004 MWD086 SEASONAL VEGETATION CONCENTRATIONS



The 2009 seasonal investigation focused on collection of forbs from thirteen (13) locations in the spring event (June). A subset of stations sampled in the spring was re-sampled for forbs in the fall (late August). Therefore, sample collection targeted the periods of elevated and low selenium concentrations as indicated by the 2004 seasonal study (**Figure 4-3**). The 13 forb samples were collected from the five waste rock dumps (eight samples) and haul road (two samples). In addition, a Site background area was sampled (three samples).

Two preliminary COCs/COECs (selenium and molybdenum) are focused on here because they report the highest concentrations compared to their background levels. This data set exhibits a very wide range of selenium and molybdenum concentrations in the spring and fall as shown on **Figure 4-4** and **Table 4-4**. Of the 13 forb samples, six forb samples are higher for selenium and seven samples are higher for molybdenum in the spring. Overall, the results of the 2009 seasonal vegetation investigation did not demonstrate a pattern of differences in vegetation concentrations between the spring and fall sampling rounds.

FIGURE 4-4
2009 SEASONAL FORB INVESTIGATION CONCENTRATIONS



4.2.5 2009 Culturally Significant Upland Vegetation Investigation

Opportunistic samples of CS plants were collected from the potential source areas and background locations where CS plants were identified. Five samples were collected from waste rock dumps (aspen or sagebrush) and two samples from the background area (juniper). Selenium and radium-226 (uranium) are the only preliminary COCs identified based on human health risks for CS vegetation. **Table 4-5** presents selenium and uranium concentrations as radium-226 was not directly measured in the vegetation samples.

As shown in the **Table 4-5**, concentrations of selenium and uranium in CS vegetation collected on the waste rock dumps are low and range between 0.504 and 5.26 mg/kg for selenium and <0.0978 and <0.0986 mg/kg for uranium. For reference, the P4 Sites selenium and uranium background levels are 3.41 mg/kg and 0.162 mg/kg, respectively. The maximum selenium concentration of 5.26 mg/kg came from a leaf sample collected from an aspen tree, while the remaining CS samples report selenium concentrations between 0.504 and 1.78 mg/kg, which is well below the background level. The two CS vegetation samples collected in the background area have selenium concentrations of 0.18 and 0.19 mg/kg and non-detect at the method detection limit (MDL) for uranium.

4.2.6 Riparian Vegetation Characterization

In September 2004, a riparian habitat assessment included evaluation of soil, vegetation, and species assemblages (see Section 4.6.1 for additional discussion). These assessments were conducted at the riparian areas of ponds (MSP), seeps (MDS), springs (MSG), and streams (MST) throughout the Site. Riparian soil and vegetation samples were collected at 28 locations (**Drawing 4-6**) for laboratory analysis of cadmium, copper, molybdenum, selenium, and zinc. These data are provided in **Appendix B**, **Table B-3**. The co-located riparian soil results are discussed in Section 4.3. Individual riparian vegetation samples represent composite samples across multiple species and plant types collected in the riparian corridor, and thus it is not possible to segregate riparian vegetation results by plant species. For the purpose of the risk estimates as discussed in **Appendix A**, it was assumed that all measured riparian vegetation concentrations were collected from culturally significant vegetation species. The preliminary COCs for CS riparian vegetation are selenium (measured vegetation concentrations) and vanadium (modeled vegetation concentrations based on riparian soil concentrations). As vanadium was not measured in riparian vegetation, only selenium is presented on **Drawing 4-6** and further discussed below. Vanadium is discussed in Section 4.3 as a preliminary COC/COEC for riparian soil.

4.2.6.1 Ponds

Riparian vegetation samples were collected from each of the four Site ponds. Selenium concentrations in riparian vegetation samples collected adjacent to the ponds range from 3.3 mg/kg at MSP014 to 65.0 mg/kg at MSP055 compared to a background level of 0.80 mg/kg. As discussed in Sections 4.3 and 4.4, the ponds also have elevated concentrations of several preliminary COCs/COECs in riparian soil, sediment and surface water samples.

4.2.6.2 Seeps and Springs

Selenium concentrations in riparian vegetation collected from two of the three sampled seep or spring locations (MDS022 and MSG002) are <0.5 mg/kg. The selenium concentration in a riparian vegetation sample collected from seep MDS016 is 0.70 mg/kg, which is below the background level of 0.80 mg/kg. Both MDS016 and MDS022 report elevated selenium concentrations in riparian soil and sediment samples collected at these locations, but do not always have exceedances of selenium in surface water (see Sections 4.3 and 4.4).

4.2.6.3 Streams

With the exception of a stream location along the Little Blackfoot River (MST044), the remaining 20 stream stations reported non-detectable concentrations of selenium (<0.5 mg/kg). The selenium concentration in the riparian vegetation sample collected at MST044 is 7.9 mg/kg, which is an order of magnitude greater than the background level. As further discussed in Sections 4.3 and 4.4, the MST044 location, which is located downstream of waste rock dump MWD088, also has elevated concentrations of selenium in riparian soil and surface water. However, the location is also very near or on the trace of the ore-bearing Meade Peak Member.

4.3 RIPARIAN SOIL AND SEDIMENT

This section presents the nature and extent of preliminary COCs/COECs detected in riparian soil and sediment at the Site. The evaluation of nature and extent for these two media are combined in this RI as they were in the *Ballard FS Memo #1 and #2* (MWH, 2016a and 2016b), because riparian soil and sediment at the Site are adjacent and contiguous, and remedial alternatives proposed for these media in the future FS likely will be similar. Data for characterization of riparian soil and sediment at the Site were collected at 28 stations during the 2004 investigation and five stations (three ponds and 2 streams) in 2010. **Drawings 4-7** and **4-8** show the locations where the riparian soil and sediment samples discussed in this section were collected. **Drawing 4-7** shows the northern portion of the Site while **Drawing 4-8** shows the southern sampling locations.

Riparian Soil - In fall 2004, riparian soil and vegetation samples were collected from 28 stations and analyzed for eight constituents (cadmium, chromium, copper, molybdenum, nickel, selenium, vanadium, and zinc). The 2004 riparian soil samples were discrete samples collected from 0 to 2 inches bgs. Riparian vegetation samples also were collected along with the riparian soil samples and those results are discussed in Section 4.2.

In order to fulfill a data gap identified by the A/Ts, additional riparian soil, sediment, and surface water samples were collected from pond and stream sampling stations for an expanded list of constituents during a fall 2010 investigation at the Site. The expanded suite of constituents included 18 metals and metalloids that were the same as the 2009 upland soil/waste rock investigation. The 2010 riparian soil samples were three-point composite samples collected from 0 to 6 inches bgs along each bank at three locations (MST053 and MST275A and MST275B) for a total of six riparian soil samples.

Sediment - Sediment samples were collected at 22 stations in fall 2004 for laboratory analysis of the same eight constituents run on the riparian soil samples. These samples were discrete and were collected from 0 to 2 inches bgs. Similar to riparian soil, the 2010 sediment investigation expanded the suite of constituents as discussed above. The 2010 sediment samples were three-point composite samples collected from 0 to 6 inches bgs from across the streambed at two locations (MST053 and MST275) and another four to five samples collected from each of the sampled Site ponds (MSP014, MSP015, and MSP016) depending on the size of the pond.

The results for the 2004 and 2010 monitoring events are presented in various RI documents such as the *2010/2012 DSR* and complete results are reported in **Appendix B**, **Tables B-4** and **B-5**. Station locations and their preliminary COC/COEC concentrations are depicted on **Drawings 4-7** and **4-8** for the northern and southern areas of the Site, respectively. On these drawings and within the section text, the identified preliminary COCs/COECs also are compared to background levels to further screen results.

4.3.1 Preliminary Contaminants in Riparian Soil and Sediment

Based on the 2004 and 2010 results evaluated in the BRA, preliminary COCs/COECs for direct and indirect pathways identified for either riparian soil or sediment are:

- Arsenic, cadmium, chromium, copper, molybdenum, nickel, radium-226 (modeled from uranium), selenium, vanadium, and zinc.

Radium-226 was not directly measured/analyzed in riparian soil or sediment, however, total uranium concentrations are shown on **Drawings 4-7** and **4-8**.

The following discussions of the preliminary COCs/COECs in riparian soil and sediment at the Site is organized by location type listed below:

- Ponds – Section 4.3.2
- Seeps/springs – Section 4.3.3
- Streams – Section 4.3.4

4.3.2 Pond – Riparian Soil/Sediment Results

Riparian soil samples were collected from areas adjacent to the four Site ponds (MSP014, MSP015, MSP016, and MSP055) in 2004, and the sample nomenclature follows the pond designation. The soil samples collected near MSP016, MSP015, and MSP014, from north to south, are located on waste rock dump MWD086. Note that the MSP016 and MSP015 riparian soil sample results are depicted on **Drawing 4-7** and MSP014 result is shown on **Drawing 4-8**. MSP055 is located in the bottom of mine pit MMP044 (**Drawing 4-8**).

As shown on **Drawings 4-7** and **4-8**, and in **Table 4-6**, selenium concentrations collected from riparian soil adjacent to the ponds range from 11.5 to 45 mg/kg, which is above the selenium background level of 2.03 mg/kg. The highest selenium concentration in riparian soil was collected from MSP016. All of the sampled preliminary COCs/COECs (arsenic and uranium were not collected in 2004) are elevated above background levels in samples collected adjacent to the ponds. Generally, the highest preliminary COC/COEC riparian soil concentrations are found in the samples collected near MSP055 and MSP016 and the lowest riparian soil concentrations are at MSP014 and MSP015 sample locations.

Sediment samples were collected from all four ponds in 2004 and again for a longer list of constituents from three ponds (MSP014, MSP015, and MSP016) in 2010. As shown on **Drawings 4-7** and **4-8** and listed in **Table 4-6**, selenium concentrations collected from pond bottom sediment samples range from 43.4 mg/kg in MSP015 to 148 mg/kg in MSP055. These levels are above the selenium background level of 1.48 mg/kg. Other preliminary COCs/COECs are elevated above background levels in pond samples. Similar to riparian soil, the highest preliminary COC/COEC concentrations are found in sediment samples collected from MSP055.

4.3.3 Springs and Seeps – Riparian Soil/Sediment Results

Riparian soil samples were collected adjacent to two dump seeps (MDS016 and MDS022) and one spring (MSG002) in 2004, which are on or downgradient of waste rock dump MWD090 in the southern portion of the Site (**Drawing 4-8**). Selenium concentrations are above the background level of 2.03 mg/kg for MDS016 and MDS022 and are 7.8 and 6.9 mg/kg, respectively (**Table 4-7**). Similar to ponds, these two dump seeps have riparian soil concentrations that are elevated above background levels for several other preliminary COCs/COECs.

However, spring MSG002, located further away from waste rock dump MWD090, reports riparian soil concentrations below background levels for all preliminary COCs/COECs including selenium. No sediment samples were collected at this location. As further discussed in Section 4.3.4 Streams, MSG002 is located adjacent to MST063, which has elevated riparian soil preliminary COC/COEC concentrations, but not elevated sediment concentrations.

Sediment samples collected from the seeps have elevated selenium levels with a maximum selenium concentration of 9.70 mg/kg at MDS016 and 1.90 mg/kg at MDS022. The sediment background level for selenium is 1.48 mg/kg. MDS016 also reports elevated sediment concentrations of several preliminary COCs/COECs. Other than selenium and nickel, all of the other preliminary COC/COEC sediment concentrations collected from MDS022 are below background levels. Sediment was not collected at MSG002.

4.3.4 Streams – Riparian Soil/Sediment Results

Riparian soil and sediment samples were collected along three streams Lone Pine Creek, Little Blackfoot River, and Long Valley Creek as described herein and in Section 2.3 (**Drawings 2-1***,* **4-7**, and **4-8**. Associated surface water quality is discussed in Section 4.4. The nature and extent of riparian soil and sediment contamination is discussed for each of these segments.

4.3.4.1 Lone Pine Creek

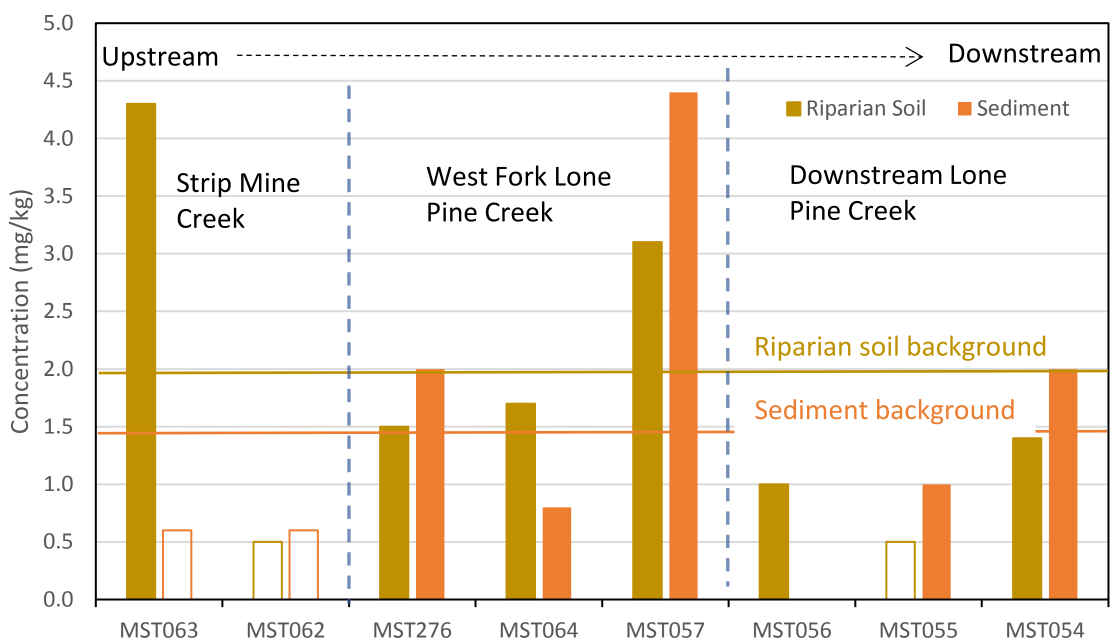
For the purpose of discussion, Lone Pine Creek is further divided into three segments (Strip Mine Creek, west fork of Lone Pine Creek, and downstream Lone Pine Creek shown on **Drawing 4-8**). Strip Mine Creek originates below the north end of waste rock dump MWD090 near the P4 haul road, and the west fork and other tributaries of Lone Pine Creek originate near the south end of MWD090. Strip Mine Creek joins Lone Pine Creek approximately one mile downstream of the Site (**Drawing 4-7**).

Along Strip Mine Creek, the riparian soil selenium concentration at the upstream location, MST063 (4.30 mg/kg), is approximately twice the background level of 2.03 mg/kg. This station also has elevated concentrations of several preliminary COCs/COECs including chromium, copper, molybdenum, nickel, and zinc. However, approximately half a mile downstream at MST062, all sampled preliminary COC/COEC concentrations including selenium have decreased below background concentrations as shown on **Drawing 4-8** and **Figure 4-5.** All preliminary COC/COEC sediment concentrations, including selenium, are below background levels in both the upstream (MST063) and downstream (MST062) Strip Mine Creek stations.

Along the west fork of Lone Pine Creek, both MST064 and MST276, on separate upstream branches, have riparian soil selenium concentrations (1.70 mg/kg at MST064 and 1.50 mg/kg at MST276) below the background level (**Drawing 4-8** and **Figure 4-5**). However, several preliminary COCs/COECs concentrations (cadmium, chromium, molybdenum, nickel, and zinc) are elevated above their respective riparian soil background levels. Further downstream at MST057, riparian soil selenium concentration increase to 3.10 mg/kg (**Drawing 4-8** and **Figure 4-5**), which is above the background level. In addition, the cadmium concentration at MST057 (5.72 mg/kg) is slightly elevated (less than 15 percent) above the background level (5.03 mg/kg). All other preliminary COC/COEC concentrations in the riparian soil sample collected from MST057 are below background levels.

Further downstream (**Drawing 4-7**), concentrations of all preliminary COCs/COECs in the riparian soil sample collected at MST056, located just upstream of the confluence between the Strip Mine Creek and Lone Pine Creek, are below background levels. This trend of decreasing constituent concentrations continues downstream with no exceedances above background levels reported in riparian soil samples collected from MST055 and MST054, located on the main stem of Lone Pine Creek.

FIGURE 4-5
MAXIMUM SELENIUM CONCENTRATIONS IN RIPARIAN SOIL AND SEDIMENT ON LONE PINE CREEK BELOW SITE



Notes: Open box is a nondetect concentration reported at the MDL.

As shown on **Drawing 4-8** and **Figure 4-5**, selenium concentrations in sediment samples collected along the west fork of Lone Pine Creek are below the background level of 1.48 mg/kg at MST064 (0.80 mg/kg), but above the background level at MST276 (2.00 mg/kg). Several other preliminary

COCs/COECs exceeded background levels at the stations including cadmium, chromium, and vanadium. Similar to riparian soil, the selenium concentration in the sediment sample collected at downstream station MST057 increases to 4.40 mg/kg, and the cadmium concentration (4.48 mg/kg) is slightly above its background level of 4.17 mg/kg. Concentrations of all sediment preliminary COCs/COECs at downstream stations MST056, MST055 and MST054, are below background levels with the exception of a selenium concentration of 2.00 mg/kg at MST054 (**Drawing 4-7** and **Figure 4-5**).

Other Stations

Three sampling stations are located further east on tributaries of Lone Pine Creek. These stations, MST058, MST226 and MST275, were assigned as Site surface water stations, because they are located on tributaries of the Lone Pine Creek drainage, for which, the Henry Site is the dominant feature in the watershed (**Drawing 4-8**). Stations MST226 and MST275 initially were proposed as background stations as they are not downstream of any Site features. However, it was established that the drainage containing MST226 has waste rock in the extreme upper end and possible seep input from the adjacent Wooley Valley Mine. Station MST275 is well away from the Site and does not have any apparent mine facilities in the watershed (being located approximately midway between the Wooley Valley and Enoch Valley Mines). However, concentrations observed at this location were determined to be uncharacteristic of background, and therefore, the location was dropped from the background dataset at the suggestion of the A/Ts. Station MST058 is downstream and in the same drainage as MST226. Because these stations were identified as being associated with the Site and not background locations, they were included in the risk calculations for the Site (see Section 6.0).

None of these stations reported selenium concentrations in riparian soil samples above background levels. Both MST226 and MST058 have riparian soil preliminary COC/COEC concentrations that are above background levels. Riparian soil samples collected near MST275 have no preliminary COC/COEC concentrations above background levels.

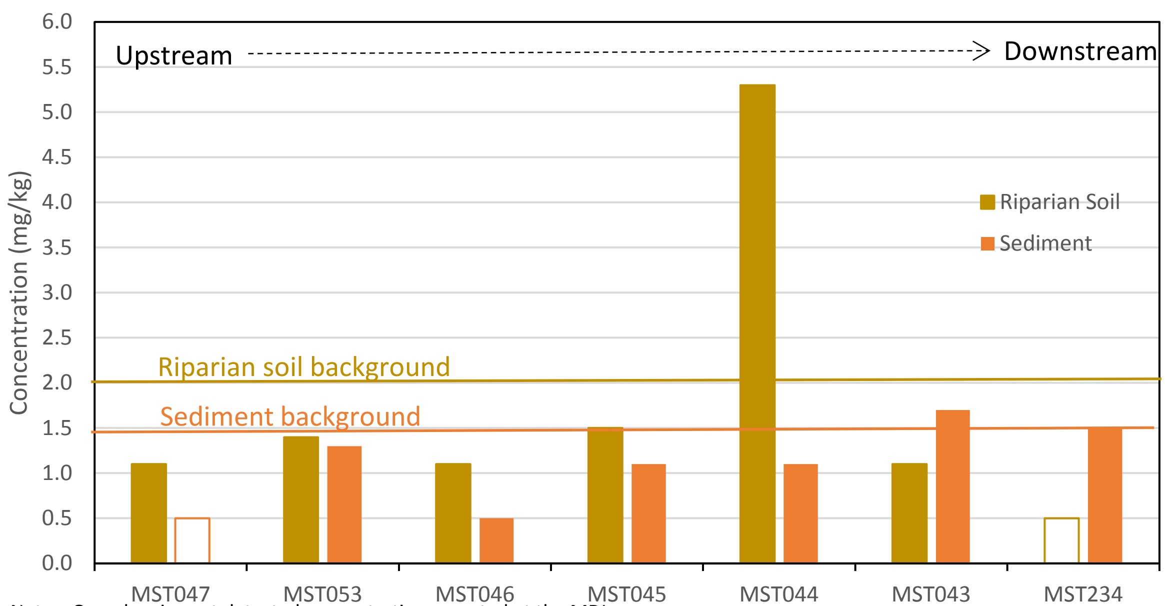
Sediment samples were collected from two of these stations (MST058 and MST275). Only MST058 has a selenium concentration in sediment (2.00 mg/kg) above its background level (1.48 mg/kg). No other preliminary COC/COEC concentrations in sediment are above background levels at MST058. At MST275, both copper and nickel concentrations in sediment samples were reported above their background levels.

4.3.4.2 Little Blackfoot River

Seven monitoring stations on the Little Blackfoot River (MST043, MST044, MST045, MST046, MST047, MST053, and MST234) were sampled for riparian soil and sediment. A riparian sample was also collected from MST052, which is located between waste rock dump MWD088 and station MST044. As depicted on **Drawing 4-7**, only MST044 and MST052 have preliminary COC/COEC concentrations in riparian soil greater than background levels. Concentrations of all sampled preliminary COCs/COECs in the riparian soil sample collected from MST052 are above background levels. At MST044, selenium was detected at 5.30 mg/kg compared to a background level of 2.03 mg/kg (**Figure 4-6**), and chromium and molybdenum also exceeded background.

Only one preliminary COC/COEC exceeds its background level in the seven stations (locations) where sediment samples were collected and analyzed along the Little Blackfoot River. A sediment sample collected from MST043 has a selenium concentration of 1.7 mg/kg, slightly above its background level of 1.48 mg/kg (shown on **Drawing 4-7** and **Figure 4-6**).

FIGURE 4-6
MAXIMUM SELENIUM CONCENTRATIONS IN RIPARIAN SOIL AND SEDIMENT ON THE LITTLE BLACKFOOT RIVER



Notes: Open box is anot detected concentration reported at the MDL.

4.3.4.3 Long Valley Creek

There are two stations associated with Long Valley Creek. Sampling station MST051 is located on a tributary to Long Valley Creek below waste rock dump MWD087 (**Drawing 4-8**), and MST271 is located on Long Valley Creek just downstream of the confluence with the tributary (**Drawing 4-7**).

Sampling station MST051 often is dry as further discussed in Section 4.4. A riparian soil sample collected from MST051 in 2004 indicates all preliminary COC/COECs concentrations are below background levels with the exception of molybdenum, which is present at a concentration of 1.76 mg/kg compared to a background level of 0.653 mg/kg. The riparian soil sample collected further downstream at MST271 has no concentrations of preliminary COCs/COECs above background levels. Sediment samples were not collected at either of these stations.

4.4 SURFACE WATER

This section presents the nature and extent of preliminary COCs/COECs in surface water bodies (ponds, dump seeps/springs, and streams) throughout the Site. Extensive surface water monitoring has occurred at 30 sampling stations on and near the Site since 2004 as discussed below. The data presented herein were obtained from spring and fall sampling events (i.e., during runoff and baseflow conditions, respectively) beginning with EE/CA data collection in 2004 and has continued through RI/FS sampling in 2014. Not all of the surface water stations included in this discussion were sampled during every event or for every constituent. This was because at several points during the investigation, data quality objectives (DQOs) and sampling plans were adjusted with A/T approval based on prior results, A/T concerns, and/or other considerations. The complete results for the surface water monitoring events are presented in **Appendix B**, **Tables B-6a** and **B-6b**. Station locations along with statistical summaries of the preliminary COCs/COECs are presented on **Drawings 4-9** and **4-10**. Dissolved concentrations for the metals/metalloids are provided on these drawings and are discussed in this section as they are most relevant to the screening level criteria, with the exception of selenium (screening level based on the total fraction).

Per the approach discussed in Section 4.0 and similar to groundwater in the following section, only those surface water constituents that are identified as preliminary COCs/COECs are discussed herein. The surface water preliminary COCs/COECs designation is based on the following CERCLA criteria (USEPA, 1991).

- The constituent exceeds its respective chemical-specific screening criteria (i.e., aquatic life criteria IDAPA 58.01.02 – Idaho Water Quality Standards or USEPA National Recommended Water Quality Criteria), or
- The constituent contributes to unacceptable human health or ecological-risk based on results of the HHERA (see Section 6.0).

Selenium is the most common contaminant detected above its individual surface water screening criterion. The Federal aquatic life standard (acute and chronic) for surface water is 0.0031 mg/L total selenium. In addition, selenium is known to be directly associated with the Site sources (i.e., waste rock) as discussed in Section 2.10. The nature and extent discussion in this section, therefore, primarily focuses on this preliminary COEC.

4.4.1 Preliminary Contaminants of Concern and Contaminants of Ecological Concern in Site Surface Water

In addition to selenium, the following constituents also are identified as preliminary COCs/COECs as the result of screening criteria exceedances and risks:

- Aluminum
- Arsenic
- Cadmium
- Chromium
- Iron
- Manganese
- Nickel
- Thallium
- Zinc

However, these constituents in Site surface waters rarely exceed their individual screening criterion and often only exceed the surface water criteria in one or two locations. Therefore, they are much less important than selenium in the overall nature and extent contaminant discussion for Site surface waters. However, they are presented and discussed in those locations where they exceed applicable screening criteria.

As an example, nickel and zinc are only discussed in association with one pond location - MSP055. This location is the only place where nickel and zinc occur in concentrations of potential concern (e.g., exceed screening criteria). Thallium is associated with one isolated exceedance of the dissolved thallium criterion at MST275 and one exceedance of the total thallium criterion at MST276, as discussed in Section 4.4.4.1.

Total chromium is another identified preliminary COEC based on screening criteria. Total chromium exceeds, by less than twice, the State of Idaho hexavalent chromium chronic aquatic life standard (0.011 mg/L), but not the trivalent chromium chronic standard (0.074 mg/L) in one sample from one pond sample location (MSP055 [0.0151 mg/L, total]). Because counting total chromium as all hexavalent chromium is overly conservative at the Site, and there is only one sporadic or anomalous result that slightly exceeds the hexavalent chromium screening criterion, chromium is not discussed further. Please note that a previous chromium speciation study for solid media at the P4 Sites, including pond and stream sediment, found that hexavalent chromium was not detected in any of the sediments including pond location MSP055, which has elevated concentrations of many other constituents (MWH, 2005).

Aluminum, iron, and manganese screening criteria also are periodically exceeded, most commonly in areas with higher turbidity or that have a strong groundwater influence. It has been established through previous investigation that the occurrence of these constituents above screening criteria is an area-wide background condition commonly found in the SE Idaho Phosphate Mining District. Furthermore, when both total and dissolved concentrations have been reported, often the elevated concentrations are not present in the dissolved fraction. Therefore, the nature and extent discussion does not address these constituents.

BRA Results. In addition to constituents exceeding screening criteria, the BRA presented in Section 6.0 also identifies preliminary COCs/COECs, but from a risk perspective. Besides selenium, which is found throughout the Site surface water, the BRA identifies aluminum, arsenic, barium, boron, cadmium, manganese, nickel, uranium, vanadium, and zinc as preliminary COCs/COECs in the surface water at the Site. Aluminum and manganese are not discussed for the reasons stated in the paragraph above, and nickel and zinc are identified based on elevated concentrations of these metals at only one surface water location – pond MSP055. Therefore, nickel and zinc are only discussed in the following section regarding ponds and in association with MSP055.

Barium, boron, uranium and vanadium are identified as preliminary COC/COECs for fish and amphibians based on conservative Tier I risk assumptions in the BRA. Barium concentrations were below its background concentration at all surface water locations and boron exceeded its background concentration at only one station – stream station MST275. This station has elevated concentrations of other preliminary COCs/COECs. However, as further discussed in Section 4.4.5.1, it appears that this location is not directly associated with the Site.

Uranium concentrations that occurred above its ecological risk screening criterion were reported occasionally from on-Site pond and seep locations. The maximum uranium concentration that drove the Tier I risk as reported in **Table 6-16** was reported at station MST064 during one sampling event in Spring 2006.

Vanadium concentrations were above its ecological risk screening criterion at four locations including pond MSP055. The other three locations (MST044, MST234, and MST280) reported anonymously higher concentrations during one sampling event in Spring 2008 that are not supported by other results. For example vanadium concentrations at MST044 from 15 sampling events ranged from non-detect (<0.005 to 0.0083 mg/L) except for a concentration of 0.089 mg/L in Spring 2008.

Exceedances by boron, uranium, and vanadium of both background and ecological benchmarks are documented and included as preliminary COECs in **Table 7-3**, however, due to the isolated nature of exceedances of ecological screening criteria and the fact that there are not promulgated standards or ARARs for these analytes, they are not discussed further in this section.

In summary, arsenic, cadmium, and selenium are identified as the key preliminary COCs/COECs based on their exceedances of screening levels and risk criteria at more than a single location. Therefore, these contaminants are discussed throughout this section, and where necessary (at individual locations), other preliminary COCs/COECs also are discussed. It should be noted that arsenic and cadmium primarily occur in one location (MSP055 - where nickel and zinc also are elevated). With this location excluded only selenium and cadmium would be risk-based preliminary COECs. Summary statistics by location for the preliminary COCs/COECs are shown on **Drawings 4-9** and **4-10**.

The following discussions of the preliminary COCs/COECs in surface water collected at the Site is organized by location type listed below:

- Ponds (MSP) – Section 4.4.2
- Seeps/springs (MDS/MSG) – Section 4.4.3
- Streams (MST) – Section 4.4.4

4.4.2 Ponds – Water Sampling Results

On June 14 and 15, 2004, representatives from IDEQ, supported by the USEPA, USFS, BLM, USFWS, and accompanied by P4 (and their consultant), conducted functional use inspections (FUIs) of the non-regulated surface water features at the Henry Site as well as P4's Ballard and Enoch Valley Sites (IDEQ, 2004b). The purpose of the FUIs was to assign the appropriate risk management action levels to non-regulated surface water features (i.e., facility ponds) based on a reasonable assessment of the existing and potential future uses of the features. The FUIs evaluated the function, habitat, and uses of the ponds. In accordance with IDEQ's *Area Wide Risk Management Plan* (IDEQ, 2004a), three selenium action level tiers were established for non-regulated surface waters:

- Tier 1 was the most restrictive selenium action level in place at the time of the survey - 0.005 mg/L based on USFWS/Department of Interior guidance for the protection of nesting and breeding waterfowl, amphibians, and other sensitive riparian species. Tier 1 was assigned to surface water features that appeared to provide adequate open water, emergent vegetation, protective cover, and food sources to support a local resident migratory bird population during typical nesting/breeding seasons.
- The Tier 2 selenium action level was set at 0.05 mg/L based on veterinary guidance for the protection of domestic livestock. This action level was assigned to surface water features within grazing allotments, those exhibiting evidence of livestock use, or ponds with a reasonable potential for future use as drinking water for livestock.
- The final selenium action level, Tier 3, was set at 0.201 mg/L based on IDEQ's risk management action level calculations for use as an occasional drinking water source by transitory terrestrial wildlife as opposed to the more restrictive uses assigned under Tier 2.

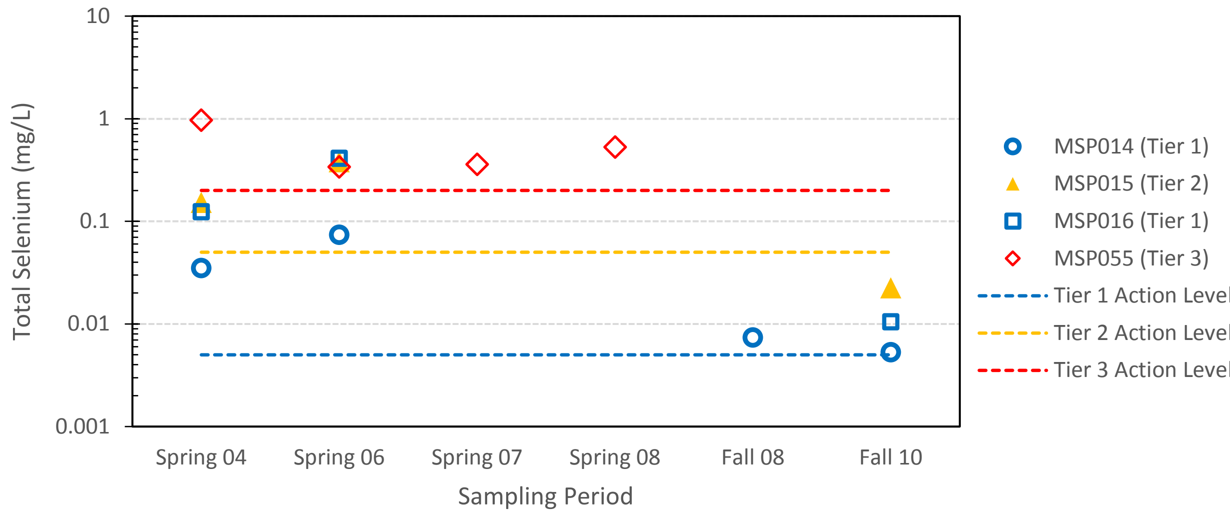
Results of the FUIs are summarized in **Table 4-8**.

The selenium concentrations and statistics are compared to the action levels as depicted on **Drawings 4-9** and **4-10.** FUI actions levels were not assigned for other preliminary COCs/COECs, so surface water criteria are used on the drawings. However, these criteria are regulatory standards that are not applicable to the ponds. Complete RI analytical data for pond water samples are provided in **Appendix B**, **Table B-6a**. In addition, **Table 4-9** provides data specific to the preliminary COC/COEC results for the pond water samples.

The selenium concentrations from all sampling events in both Tier 1 ponds exceeds the action level (0.005 mg/L) and ranges between 0.0053 in MSP014 to 0.41 mg/L in MSP016 (**Figure 4-7**). The fall concentrations in both ponds are significantly lower than those reported in the spring and are near the action level. This "higher concentration in the spring" trend also is observed in pond water samples collected from the Tier 2 pond MSP015 with spring exceedances of the selenium action level (0.05 mg/L), contrasted to the single measured fall selenium concentration of 0.0225 mg/L, which is below the action level. The selenium concentrations in MSP055, located in South Henry

Pit, exceed the Tier 3 selenium action level (0.201 mg/L) in the spring and ranges from 0.34 mg/L to 0.97 mg/L. This pond typically is dry in the fall (note the absence of sampling data in the fall on **Figure 4-7**).

FIGURE 4-7
SELENIUM CONCENTRATION IN PONDS COMPARED TO ACTION LEVELS



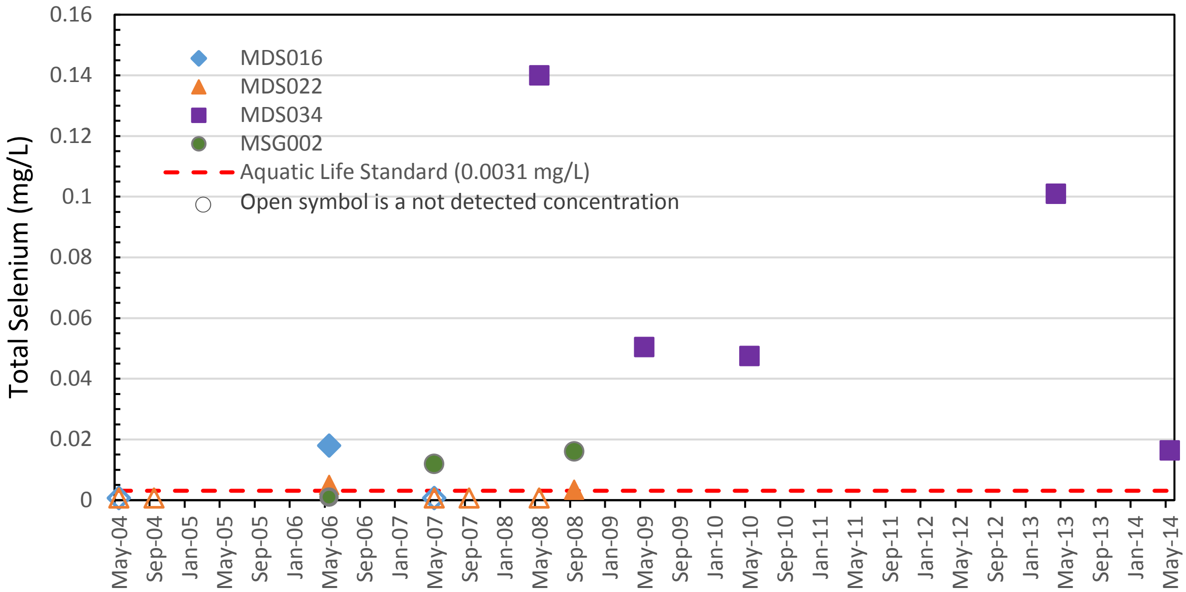
Action levels for other preliminary COCs/COECs were not established in association with the FUIs. However, consistent with the presentation for other surface water bodies at the Site, arsenic and cadmium concentrations for the four ponds are reported in **Table 4-9** and on **Drawings 4-9** and **4-10**. State of Idaho Surface Water Quality Standards for aquatic life (screening criteria) may not apply to the Site ponds. However, for reference the arsenic standard is 0.01 mg/L and cadmium is approximately 0.001 mg/l depending on hardness. Arsenic is notably below its surface water criterion except for one event at MSP055 in the spring 2008.

Similarly, cadmium in pond water is consistently above criterion in pond MSP055. However, because MSP055 is a Tier 3 pond not suitable for aquatic life, State of Idaho aquatic life standards are not a relevant point of comparison. Other preliminary COECs based on the BRA include dissolved nickel (0.344 – 1.26 mg/L) and zinc (1.79 – 4.73 mg/L); these constituents are similarly elevated in MSP055 compared to other Site locations (**Appendix B**, **Table B-6a**). In large part, it is because of elevated surface water data collected from MSP055 that these analytes (arsenic, cadmium, nickel and zinc) are identified as preliminary COECs.

4.4.3 Springs and Seeps – Water Sampling Results

The Site has three monitored dump seeps (MDS016, MDS022, and MDS034) and one spring (MSG002) which is located off of MWD090 (**Drawings 4-9** and **4-10**). Only selenium commonly exceeds surface water screening criteria in these locations. The concentrations and trends in selenium for these four seep/spring locations are shown on **Figure 4-8** and tabulated in **Table 4-10**.

FIGURE 4-8
SELENIUM CONCENTRATION IN SEEPS AND SPRINGS



Selenium rarely has been detected in water collected from MDS022. However it has exceeded the selenium criterion during two sampling events. One of three surface water samples collected from MDS016 (0.018 mg/L) exceeds the screening criterion (0.0031 mg/L), and two of three samples from MSG002 (0.012 and 0.016 mg/L) exceeds the screening criterion. Samples from MDS034 consistently exceed the selenium criterion with concentrations up to 0.14 mg/L total selenium in the spring. The MDS034 location has been dry in the fall when visited (**Table 4-10**).

The measured concentrations of cadmium (key preliminary COC/COEC) in the seeps and springs are typically reported at the MDL (e.g., <0.0001 mg/L) as shown in **Table 4-10** with a maximum cadmium concentration of 0.0008 mg/L in MDS016 (spring 2006). Arsenic concentrations ranged from <0.0005 mg/L in MDS022 (spring 2006) to 0.0079 mg/L in MDS034 (spring 2008). These cadmium and arsenic concentrations are below their screening criteria of 0.0013 mg/L (cadmium) and 0.0062 mg/L (arsenic).

4.4.4 Streams – Water Sampling Results

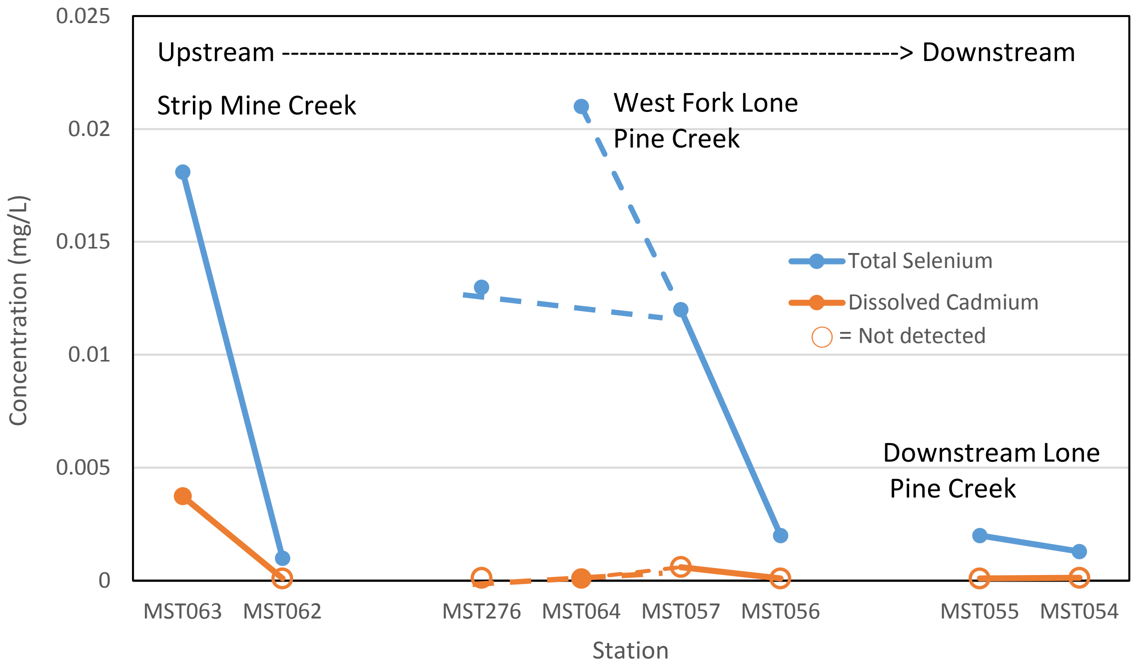
The streams potentially affected by the Site are portions of Lone Pine Creek, Little Blackfoot River, and Long Valley Creek (**Drawings 2-1**, **4-9**, and **4-10**) discussed in Sections 2.3 and 4.3. Lone Pine Creek flows from the southeastern corner of the Site north and westward towards its confluence with the Little Blackfoot River. The Little Blackfoot River then traverses the Site through the northern end. One small stream originates along the southwestern side of the Site and flows to Long Valley Creek (**Drawing 4-10**). The nature and extent of contamination is discussed in each of these streams as they pass through the Site.

4.4.4.1 Lone Pine Creek

As discussed in Sections 2.3 and 4.3, Lone Pine Creek is divided into three segments (Strip Mine Creek, west fork of Lone Pine Creek, and downstream Lone Pine Creek). Strip Mine Creek and Lone Pine Creek combine approximately one mile downstream of the Site (**Drawings 4-9** and **4-10**) and Lone Pine Creek continues north and flows into the Little Blackfoot River.

The majority of the spring and seep flows originating on Site discharge to the headwaters of the Strip Mine Creek and Lone Pine Creek, and several of these groundwater discharge sources have elevated preliminary COC/COEC concentrations. Therefore, the upstream surface water stations near the mine waste dumps and associated seeps and springs are affected by contaminated groundwater discharge. However, the effects of groundwater discharges dissipate downstream through attenuation (e.g., dilution, sorption, or redox reactions). This result is clearly shown in **Figure 4-9** for selenium and cadmium, which shows the maximum measured concentrations for the Lone Pine Creek stations.

FIGURE 4-9
MAXIMUM SELENIUM AND CADMIUM CONCENTRATIONS ON LONE PINE CREEK BELOW SITE



Note: MST064 and MST276 are on two separate tributaries to the West Fork of Lone Pine Creek and the dashed lines indicate that these stations are located on two distinct tributaries to the West Fork of Lone Pine Creek.

Stations MST063, MST276, MST064, and MST057 are all located near the Site (within a half mile or less). **Drawing 4-10** provides the spatial reference along with associated total selenium concentration statistics for each of these stations. Selenium concentrations decrease to well below the screening criterion of 0.0031 mg/L at the downstream-most station on the west and east forks as well as on the combined main stem stations of Lone Pine Creek (**Figure 4-9** and **Drawing 4-10**).

Cadmium is detected at an elevated concentration in surface water collected at station MST063 located at the headwaters of Strip Mine Creek. MST063 is dominated by groundwater discharge from spring MSG002 and dump seep MDS022, as well as likely groundwater baseflow discharge directly to the channel. All other maximum cadmium concentrations for other stations on the creek are non-detect (<0.0001 to <0.0003 mg/L) with one detected concentration of 0.0001 mg/L. For reference, the screening criterion for cadmium is approximately 0.001 mg/L depending upon hardness.

Arsenic is identified as a preliminary COC based on risk as presented in Section 6.0 and has been detected at a concentration of:

- 0.001 mg/L dissolved at station MST064 in spring 2006
- 0.0006 mg/L dissolved at station MST057 also in spring 2006
- 0.0011 mg/L total at station MST276 in spring

These are all headwater locations near the waste rock dumps. Other measured arsenic concentrations for downstream Lone Pine Creek stations are <0.0005 mg/L. The relevant screening criterion (aquatic life standard) is 0.01 mg/L, and all measured concentrations are well below the criterion.

None of the other preliminary COCs/COECs discussed in the opening of this section occur at concentrations above screening criteria except possibly thallium at station MST276. A concentration of 0.006 mg/L total thallium was measured at MST276 in the fall 2007 sampling event, with the associated dissolved concentration being non-detect (<0.0001 mg/L). Measured thallium concentrations at this station in the spring 2006 and 2008 were all non-detect (<0.0001 mg/L). Thallium is not detected at any other station in the Lone Pine drainage below the Site.

Other Stations

Three sampling stations are located further east on tributaries of Lone Pine Creek. These stations, MST058, MST226 and MST275, were assigned as Site surface water stations because they are located in the Lone Pine Creek drainage, for which, the Henry Mine is the dominant feature in the watershed (**Drawing 4-10**). As discussed in Section 4.3, stations MST226 and MST275 were initially proposed as background stations, but were removed as background stations based on A/Ts concerns that these locations could be influenced by another nearby mine (i.e., nearby Wooley Valley Mine). Station MST058 is downstream and on the same drainage as MST226. Because the stations were identified as being associated with the Site and as not being background, they are included in the risk calculations for the Site as described in Section 6.0.

Concentrations of preliminary COCs/COECs detected in surface water collected at MST058 and MST226 generally are not remarkable. Total selenium concentrations at MST226 generally range from <0.001 mg/L (spring 2006) to <0.00272 mg/L (spring 2013). However, a concentration 0.00833 mg/L was measured in spring 2012, which is above screening criterion. Total selenium concentrations at MST058 were <0.001 mg/L in the spring and fall 2004, but was 0.009 mg/L in spring 2006. Dissolved arsenic concentrations are non-detect (<0.0005 mg/L in spring 2006 for each station). MST226 and MST058 were sampled several times for cadmium and the results for these sampling events are non-detect at <0.0003 or <0.0001 mg/L.

Total selenium concentrations at MST275 range from <0.0005 mg/L (e.g., in spring 2013) to 0.008 mg/L in fall 2004, which is just above the screening criterion. Dissolved arsenic concentrations range from <0.0007 mg/L in spring 2006 to 0.0224 mg/L in fall 2010. The arsenic screening criterion is 0.01 mg/L. Dissolved cadmium often is not detected, but the maximum detected concentration is 0.000166 mg/L (below screening criterion) in fall 2010. The station is unusual in that it also had a maximum dissolved thallium concentration of 0.000348 mg/L (above the screening criterion); however, a second, non-duplicate, sample collected and analyzed from the same day (October 1, 2010) had a concentration of 0.000059 mg/L. The one other sample analyzed for thallium reports a concentration of <0.0001 mg/L. All of the maximum concentrations of preliminary COCs/COECs occur in the fall, with concentrations significantly lower in the spring. It does appear that preliminary COCs/COECs are elevated at MST275, but as noted, this station is not associated with the Site. Excluding it from the risk calculations, would reduce the estimated surface water risks for the Site.

4.4.4.2 Little Blackfoot River

Data from seven monitoring stations on the Little Blackfoot River are used in the RI. Of these stations, MST046, MST047, MST053, near the confluence with Lone Pine Creek, and MST043 downstream of the Site were sampled once in spring 2004. The selenium concentrations for these stations are reported as non-detect (<0.001 mg/L). MST053 also was sampled in fall 2010 with a measured selenium concentration of 0.0007 mg/L. These monitoring station locations are depicted on **Drawing 4-9** with a statistical summary of data, and complete data are provided in **Appendix B**, **Tables B-6a** and **B-6b**.

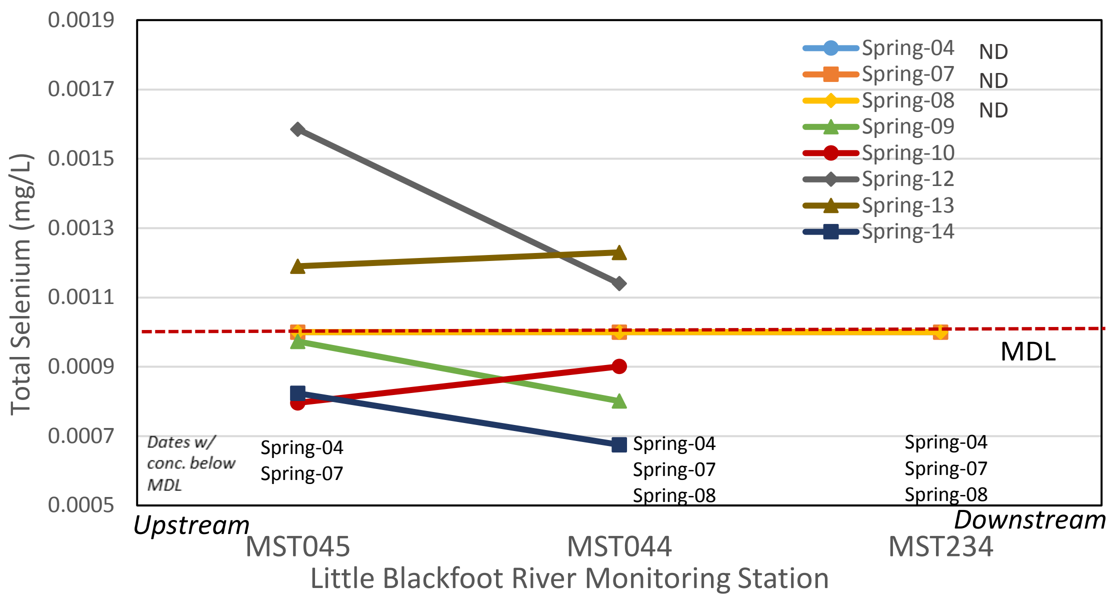
The investigation of the Little Blackfoot River focused primarily on the three other stations:

- MST045, located just upstream of the mine
- MST044, located just downstream of the mine
- MST234, located further downstream just before the Little Blackfoot River flows into Blackfoot Reservoir (**Drawing 4-9**).

Stations MST044 and MST045 each have been sampled 15 times, and MST234 five times. The total selenium for these sampling events are plotted on **Figure 4-10** for spring results and **Figure 4-11** for the fall results. With the exception of the MST044 fall 2007 sampling result, all the measured concentrations are below 0.0019 mg/L, well below the screening criterion of 0.0031 mg/L. As noted on **Figures 4-10** and **4-11**, a number of sample results are reported as <0.001 mg/L. The fall

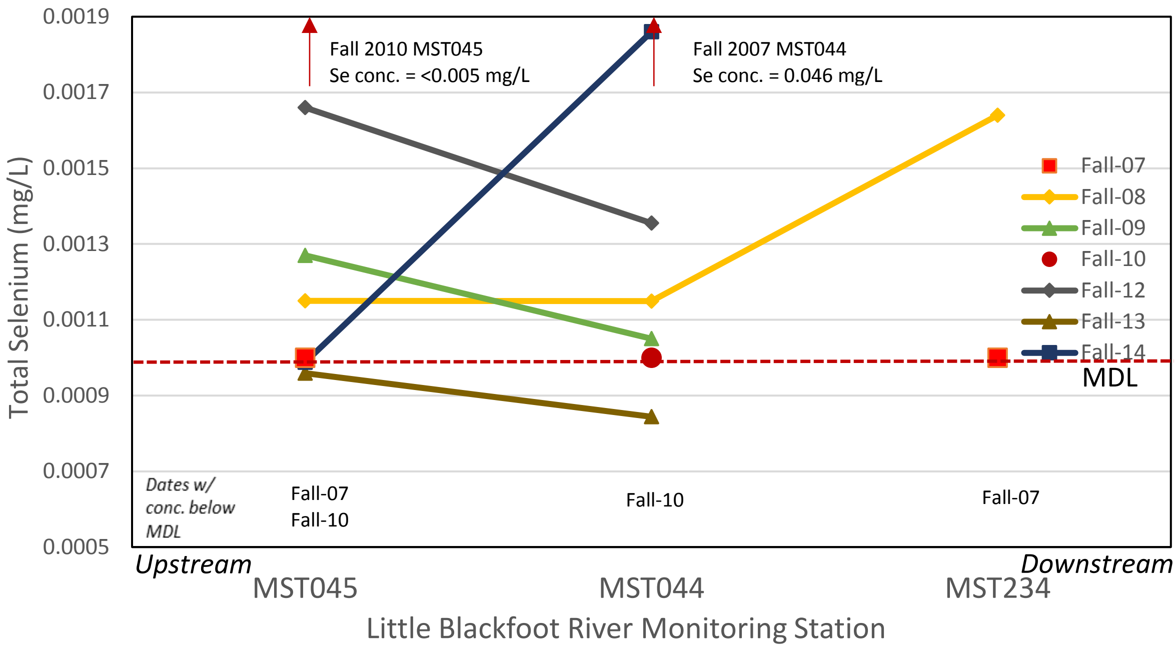
2007 result for MST044 is 0.046 mg/L (**Figure 4-11**). This result is anomalous being the highest selenium concentration measured on the Little Blackfoot River by more than an order of magnitude, and additionally, selenium was not detected at 0.001 mg/L both upstream (MST045) and downstream (MST234) during the sampling event. The concentration cannot be discounted based on quality control data; nonetheless, it appears to be erroneous or anomalous data. Separately, the results from MST044 for the spring 2014 sampling event, the *dissolved* selenium concentration was reported as 0.00579 mg/L, above the selenium screening criterion, but the *total* selenium concentration was reported as 0.000675 mg/L for the same sample. One of the two results has to be erroneous as the dissolved concentration cannot exceed the total concentration by nearly an order of magnitude. In addition, the screening criterion is for total selenium, which is not exceeded by the total concentration.

FIGURE 4-10
SPRING SELENIUM CONCENTRATION ON LITTLE BLACKFOOT RIVER



Notes: * - MDL ranged from 0.001 to 0.005 mg/L, all but one non-detected concentration had an MDL of 0.001 mg/L and all points shown as 0.001 mg/L were not detected.
ND – Concentrations for 2004, 2007 and 2008 were all not detected at the MDL of 0.001 mg/L. Sampling was not conducted in 2011.

FIGURE 4-11
FALL SELENIUM CONCENTRATION ON LITTLE BLACKFOOT RIVER



Notes: * - For fall samples MDL was 0.001 mg/L, except for 0.005 mg/L at MST045 in Fall 2010. All points shown as 0.001 mg/L were not detected.
Sampling was not conducted in 2011.

What is shown on **Figures 4-10** and **4-11** is that selenium only increases between MST045 and MST044, across the Site, in three of the 15 events. Only during the fall 2014 event did the concentration increase by more than 15 percent (relative percent difference). For the other 12 events, the concentrations are either unchanged upstream to downstream or decreased. The selenium concentration increases downstream to MST234 only during the fall 2008 event. For all the other events when MST234 was sampled, selenium is not detected at the station. Based on the selenium data collected and an interpretation of the range of concentrations, it does not appear that the Site is affecting the Little Blackfoot River directly with Site preliminary COCs/COECs.

For the seven Site stations monitored along the Little Blackfoot River during the RI, 38 results are available for dissolved cadmium (triplicates and duplicates as one average result). Of these results, there is only one detected concentration of 0.000012 mg/L at MST053 in the fall 2010 sampling event (**Drawing 4-9**). All other cadmium concentrations are non-detect for the various sampling events ranging from <0.0001 to <0.0006 mg/L.

Arsenic has rarely been analyzed for at the Little Blackfoot River stations. A result of 0.00075 mg/L is reported for station MST053 upstream of the Site in fall 2010, and a result of 0.00053 mg/L is reported for MST234 downstream of the Site in spring 2006 (**Drawing 4-9**).

4.4.4.3 Long Valley Creek

The tributary to Long Valley Creek that flows below waste rock dump MWD087 along the west side of the Site has a single sampling station - MST051 (**Drawing 4-10**). Sampling station MST271 is located on Long Valley Creek just downstream of the confluence with the tributary (**Drawing 4-9**). Beyond that Long Valley Creek flows into the Little Blackfoot River.

Station MST051 often is dry. It was scheduled to be sampled numerous times between 2004 and 2010. However, in spring 2004, 2006, 2007, 2008, and 2010, it was found to be dry. It was also found to be dry in fall 2007 and 2008. The only time the tributary was found to be flowing was spring 2009, and it was sampled. The total selenium concentration was measured as 0.000705 mg/L, and dissolved cadmium was <0.000125 mg/L (**Drawing 4-10**). Arsenic was not included in the analytical suite during this A/T-approved sampling program.

MST271 located downstream on Long Valley Creek was only scheduled for sampling during the spring 2004 and 2006 sampling events. The location was dry in spring 2004, but was sampled in spring 2006. Preliminary COC/COEC concentrations were similarly low. Total selenium was non-detect (<0.001 mg/L), and dissolved cadmium was reported at <0.0001 mg/L (**Drawing 4-9**). Arsenic was detected at 0.0023 mg/L, below its screening criterion of 0.0062 mg/L.

4.5 GROUNDWATER

Groundwater monitoring has occurred in the Site area since 2004 at 16 monitoring, agriculture, domestic, and production wells and a direct-push pre-packed well and at 31 direct-push boreholes. Groundwater samples collected and analyzed from these wells are used to help identify potential impacts to groundwater from the Site. Spring and fall sampling events and the data generated that began with EE/CA monitoring in 2004 and has continued through RI/FS sampling in 2014 are discussed below. Not all of the groundwater wells included in this discussion were sampled during every event or for every constituent (metals/metalloids/non-metals and general water quality parameters), because each sampling event considered changing data quality objectives (DQOs, i.e., data needs) prior to A/T-approval of individual monitoring plans.

This section then presents a summary of groundwater constituents that are identified to be preliminary COCs based on the following CERCLA criteria for when remedial action is warranted (USEPA, 1991):

- The constituent exceeds its respective chemical-specific screening criteria (i.e., Idaho groundwater standards (58.01.11) or Federal primary MCLs[3]), or
- The constituent contributes to unacceptable human-health risk based on results of the BRA (see Section 6.0).

The results of the Site groundwater monitoring events are presented in various documents, some of which are listed in Section 3.5, and the complete analytical results for each monitoring well location are presented in **Appendix B**, **Table B-7**. Groundwater well locations along with the statistical summaries of analytical results at each location are presented on **Drawings 4-11** and **4-12**.

This section also includes evaluations of select constituents that are known indicators of selenium mining impacts to groundwater (e.g., sulfate which can result from the oxidation and dissolution of sulfides in the mine wastes). Sulfate are included in the discussion of nature and extent in groundwater at the Site even though they do not exceed (or do not have) chemical-specific ARARs, or do not contribute to unacceptable human-health risk. They are compared to their Secondary MCLs (SMCL)[1] as reference points. The SMCLs are not potential ARARs.

4.5.1 Preliminary Constituents of Concern in Site Groundwater

The detected constituents in Site groundwater that exceed their respective Idaho groundwater standard or Federal primary MCL (screening criteria), are limited to selenium and cadmium. Constituents that are identified in the BRA to contribute to unacceptable human-health risk include arsenic, cobalt, and thallium.

It is notable that the three risk-derived preliminary COCs do not exceed screening criteria. (Preliminary COECs do not exist for groundwater, because there is not a complete pathway to ecological receptors.) **Table 4-11** provides the concentration ranges of these risk-based preliminary COCs in groundwater at the Site, along with their background levels and associated chemical-

[3] USEPA established maximum contaminant levels (or MCLs), to protect the public against consumption of drinking water contaminants that present a risk to human health. USEPA established Secondary MCLs (or SMCLs) only as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color and odor. These contaminants are not considered to present a risk to human health at the SMCL. SMCLs are non-mandatory and not enforced by USEPA. Although this section includes comparisons with SMCLs in order to provide reference concentrations to facilitate the evaluation of the nature and extent of contamination in groundwater at the Site, SMCL exceedances are not used to identify preliminary COCs.

specific screening criteria. They are, however, specifically discussed for those locations where they are detected. The data for the criteria-exceeding COCs, selenium and cadmium, are presented in **Table 4-12,** and summary statistics by location for all the preliminary COCs are shown on **Drawings 4-11** and **4-12**.

4.5.2 Hydrostratigraphic Units

The following discussion of the nature and extent of contamination in groundwater is presented separately for each of the three principal groundwater flow systems (or hydrostratigraphic units) discussed in Section 2.6. These include the:

- Shallow Alluvial Unit
- Dinwoody Formation
- Wells Formation

In addition, a separate discussion is included for "Other Units" to describe the groundwater sampling results for some of the older wells have missing or minimal drilling logs, and therefore, it is not known with certainty which hydrostratigraphic unit they represent.

The investigations were conducted using monitoring wells (MMW), direct-push boreholes (BH), one direct-push pre-pack well (or borehole well; MBW), and two production wells (MPW). Surface water features that discharge directly from groundwater (seeps/springs/baseflow stream discharge) are mentioned in the following discussion where relevant, but are primarily presented in the surface water discussion in Section 4.4.

In addition, agricultural (MAW) and domestic wells (MDW) have been sampled as part of the Site investigation (see **Drawing 3-3** for locations). These wells exhibit relatively elevated concentrations of aluminum, iron, manganese, and TDS in some cases (**Appendix B**, **Table B-7**). However, these exceedances were characterized as being normal regional background, and the wells were assigned to the background data set (MWH, 2013a). The selenium and cadmium concentrations for these wells are presented in **Table 4-12** and shown on **Drawings 4-11** and **4-12**. Cadmium has never been detected in any of the agricultural or domestic wells. All the selenium concentrations have been less than a maximum concentration of 0.006 mg/L with one exception. The Fall 2012 selenium concentration in MDW003 was 0.0109 mg/L, which is still much below the selenium criterion of 0.05 mg/L.

Monitoring well locations and the one direct-push (pre-pack) well location for the Site are shown on **Drawings 4-11** and **4-12**, which also displays the concentration statistics for the preliminary COCs including sulfate, which is an analyte of interest sulfate. The majority of the monitoring wells were installed in the field seasons of 2007, 2008, and 2009. Site monitoring well completion details are presented in **Tables 3-4** through **3-6**. The tables indicate the specific hydrostratigraphic groundwater unit (as discussed in Section 2.6) which each well is screened in and is intended to monitor.

A significant component of the investigation of the alluvial system was a one-time sampling program conducted using the direct-push sampling technology (as presented in MWH, 2008). Direct-push borehole locations with selenium results are also shown on **Drawings 4-11** and **4-12**. For these boreholes, groundwater was collected and analyzed for selenium only once at each location during the year of installation and were subsequently abandoned. Because the uncompleted boreholes generated highly turbid samples, all samples were field filtered per the Field Sampling Plan (MWH, 2008), and the results are for dissolved selenium.

Section 5.1 provides a more in-depth discussion of the source, transport pathways, and receptors for the Site. However, the most relevant groundwater sources, pathways, and receptors are briefly described herein to provide context for the presentation of the extent of the elevated constituent concentrations detected at the Site.

4.5.2.1 Shallow Alluvial Unit

The shallow unconfined alluvial unit contains alluvium, colluvium, and the uppermost weathered (decomposing) bedrock, and because these units have similar hydrogeologic properties, they form a single shallow hydrostratigraphic unit. At the Site, basalt located along the Little Blackfoot River between the northern and central mine pit areas also represents the uppermost shallow groundwater system and is included as part of the shallow alluvial unit because of the similar hydrogeology.

The surface watershed and shallow alluvial groundwater flow at the Site is toward the Little Blackfoot River with a large portion reaching the river via the Lone Pine Creek watershed (**Drawing 4-11**). More specifically, the bulk of the Site lies between two bedrock ridges formed by the limbs of a syncline (refer to Section 2.4). The intervening swale holds most of the waste rock, which is the known source of Site contaminants. The swale presumably contains variable thicknesses of alluvium along its length that is now covered by waste rock.

This configuration has resulted in two primary areas where the shallow alluvial system may transport COCs away from the Site. These areas are located where there are breaks in the ridges: where the Little Blackfoot River cuts through the ridge, and between the south and south-central mine area, where the current Enoch Valley haul road runs (**Drawings 4-11 and 4-12**). The distribution of preliminary COCs in the alluvial system is discussed below for the northern and southern alluvial systems.

Northern Alluvial Area

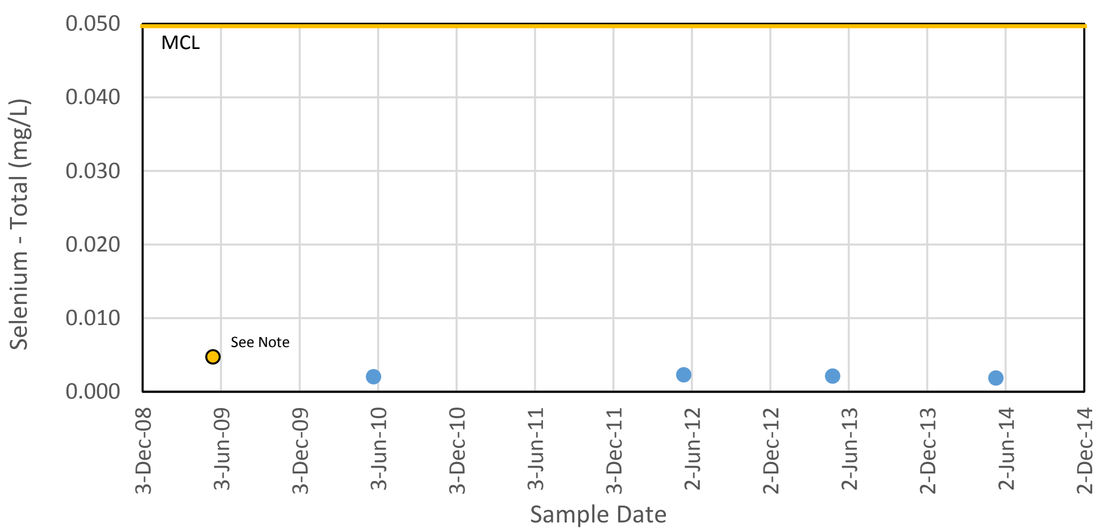
As depicted in **Drawing 4-11**, the northern area is centered along the Little Blackfoot River and contains areas of alluvium and basalt as shown on **Drawing 2-2**. Groundwater samples were collected from both direct-push and conventional monitoring wells to characterize chemical concentrations in the alluvial groundwater system. The direct-push approach was reasonably successful in the alluvial areas; however, the borings often could not be advanced to sufficient depth to obtain groundwater in the areas directly underlain by basalt.

The spatial distribution of 2008 and 2009 direct-push boreholes and measured dissolved selenium results are depicted on **Drawings 4-11** and **4-12**. Fourteen direct-push borings were advanced; however, eight were dry or refusal occurred before any groundwater was encountered.

Selenium concentrations detected in these boreholes are below the screening criterion of 0.05 mg/L with a single exception. The groundwater sample collected from direct-push borehole BH063 reports the maximum detected selenium concentration in the northern area (0.13 mg/L). This temporary borehole was located within the mine area between ponds MSP015 and MSP016 (**Drawing 4-11**). Two additional boreholes (BH061 and BH062) were advanced in a downgradient direction from BH063 along the edge of the waste rock, but bedrock was encountered before alluvial groundwater was encountered. Further downgradient, between the mine and the Little Blackfoot River, three boreholes were advanced along the toe of waste rock dump MWD088 (BH058-BH060). In the thin alluvial deposits, groundwater flow locally is directed westward toward the Little Blackfoot River following the topography and the local drainage, and roughly parallels the alignment of the three boreholes in this area.

Of these boreholes, a groundwater sample from BH059 contained 0.041 mg/L selenium. Groundwater sampled from BH058, located further downstream on the surface water channel, had a non-detectable selenium concentration (<0.001 mg/L). To address a potential northward component of shallow groundwater flow from this area or upwelling bedrock groundwater, in 2009, four additional borings were advanced between MWD088 and the river (BH150 through BH153, including BH152/MBW152). Groundwater sampled from three of the four boreholes had dissolved selenium concentrations of <0.0005 to 0.0055 mg/L and BH150 was dry. The boring immediately adjacent to the river was converted to a permanent monitoring well (MBW152). Total selenium concentrations in groundwater samples collected from MBW152 have remained below 0.0025 mg/L since the initial direct-push groundwater sample collected from the uncompleted borehole (which had a selenium concentration of 0.0047 mg/L – see **Figure 4-12**).

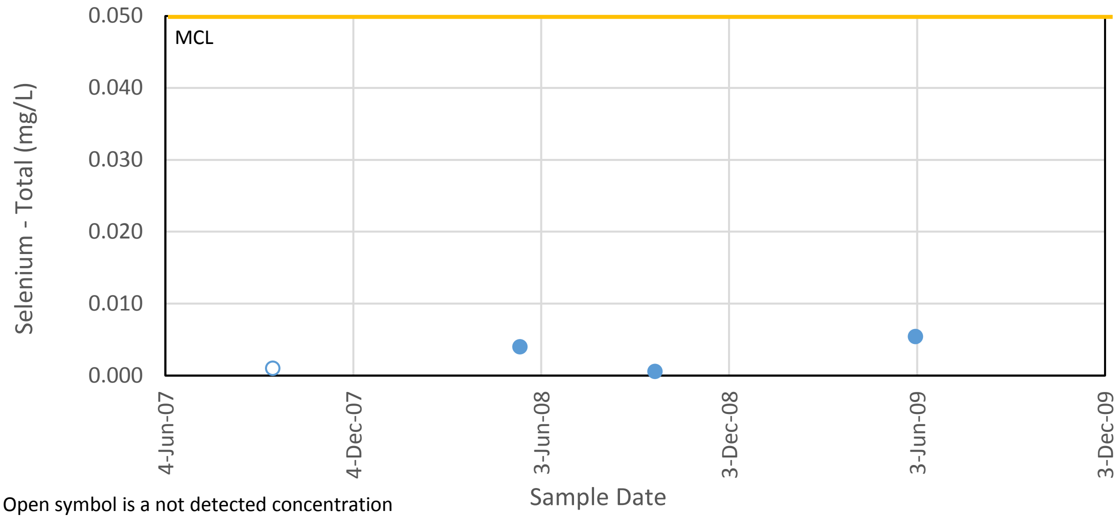
FIGURE 4-12
TIME SERIES SELENIUM CONCENTRATIONS FOR MONITORING WELL MBW152



The May 16, 2009 result was a dissolved selenium concentration collected from borehole BH152 prior to well installation

Monitoring well MMW019 (14-foot deep well) was installed on the north end of mine pit MMP043 and waste rock dump MWD088 to investigate the shallow alluvial groundwater system. However, black shale of the Phosphoria Formation was encountered at 6 feet bgs and first water was encountered at 10 feet bgs. Given the shallow depth, the water collected from this well is associated with the shallow alluvial system, despite being obtained from Phosphoria Formation shale. This is supported by the hydraulic response of the well discussed in Section 2.6. As shown on **Figure 4-13**, selenium concentrations in groundwater collected and analyzed from MMW019 have been below 0.006 mg/L.

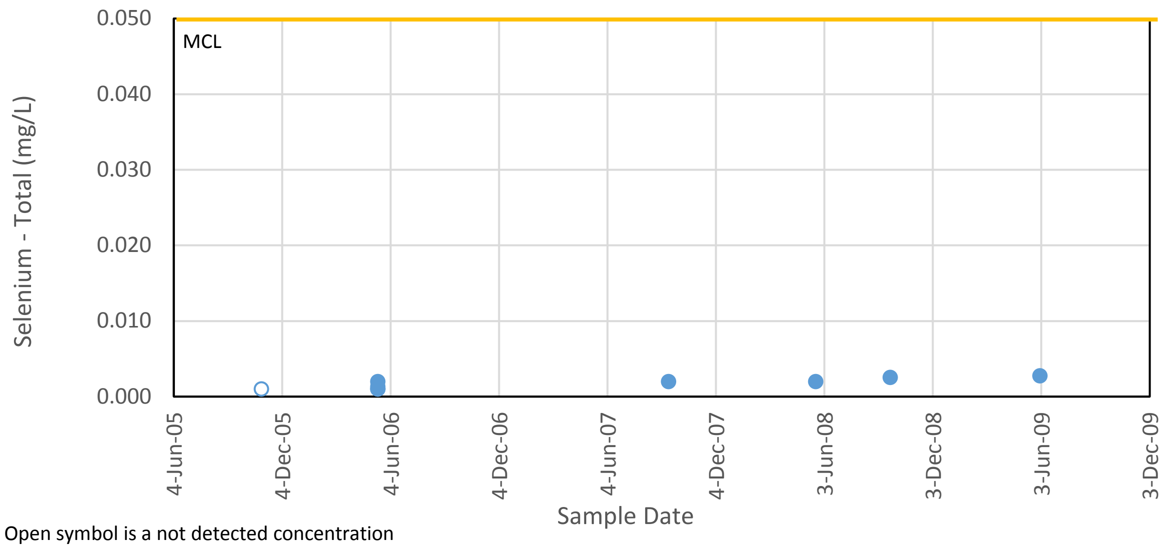
FIGURE 4-13
TIME SERIES SELENIUM CONCENTRATIONS FOR MONITORING WELL MMW019



Based on the investigation of the area just *south* of the Little Blackfoot River, it is concluded herein that elevated selenium concentrations are present in the alluvial groundwater, but where they are present, they are confined to areas beneath and immediately adjacent to the waste rock.

North of the river, the basalt is much more prominent and the direct-push program was not successful in encountering groundwater largely because of the lack of alluvium (the geologic mapping did not identify any alluvium in this area, **Drawing 2-2**). However, monitoring well MMW004 is an ideal location between the mine area (notably MWD085) and the river. Selenium concentrations in groundwater at this location are below 0.003 mg/L in all sampling events (**Figure 4-14**). No drilling log exists for MMW004. However, the well was examined with a video camera and casing length and total depth were recorded. Based on the casing depth of 55 feet (below which it is an open borehole), geology, and location, it is likely that the zone monitored is near the bottom of the basalt. Additionally, the watershed and amount of waste rock in this watershed are relatively small compared to the other Site areas, so additional investigation of the basalt was not conducted based on these results.

FIGURE 4-14
TIME SERIES SELENIUM CONCENTRATIONS FOR MONITORING WELL MMW004



Of the three (3) preliminary COCs identified in the BRA (arsenic, cobalt, thallium), arsenic is detected only in MMW004 at 0.0006 mg/L, and thallium in MMW019 is reported at the detection limit of 0.0001 mg/L. These concentrations are below background levels (**Table 4-11**). All other concentrations of these preliminary BRA COCs, as well as cobalt, are below the detection limits (**Appendix B**, **Table B-7**). **Drawing 4-11** presents concentration statistics for these preliminary COCs and spatial distribution.

The sulfate concentrations from twenty-one (21) MMW004 sample results, including four triplicates, from 2004 – 2009 are in a relatively narrow range between 112 and 137 mg/L (**Appendix B**, **Table B-7**). These results do not exhibit any significant seasonal variability. The TDS results for these same MMW004 events exhibit a similar narrow range (460 – 548 mg/L).

Four sulfate results for MMW019 from 2007 to 2009 range from 55 to 159 mg/L with the lowest concentrations in the spring. The associated TDS results for MMW019 range from 308 to 554 mg/L with the same seasonal pattern. The observed seasonal pattern in MMW019 sulfate and TDS results is consistent with the shallow runoff interflow source of water discussed in Section 2.6.

The observed sulfate concentrations in both of these two wells are consistent with them being unimpacted by Site sources. The TDS concentrations in these two wells periodically exceed the SMCL (SMCLs are used as reference points only for these general water quality parameters). Typically, where this occurs at the P4 Sites, it is due to elevated sulfate. However, in this northern area it is because of a sodium-chloride component that is not apparently related to the Site and is discussed further in Section 4.5.3.

__Southern Alluvial Area__

The southern alluvial area includes the groundwater flow from beneath the Site's southern external waste rock dumps (most of MWD086 and all of MWD090, **Drawing 4-12**). The alluvial groundwater flow in this area is eastward then northward along Lone Pine Creek. The alluvium in this area was investigated using direct-push borings and two monitoring wells – MMW010 and MMW014. Basalt is not present in the southern area.

As a result of detected selenium concentrations in MMW010 (up to 0.219 mg/L; discussed below) and area surface water (discussed in Section 4.4), direct-push borings (BH029 to BH030, BH073 to BH077, BH157 to BH158, and BH167 to BH171) were advanced in downgradient locations between 2008 and 2010 (**Drawing 4-12**). Selenium concentrations in the groundwater samples collected from these borings are below the criterion of 0.05 mg/L.

The selenium concentration detected in BH074, located near MMW010, of 0.031 mg/L was consistent with MMW010 selenium concentrations. Boreholes downgradient of this area were either dry or had selenium concentrations less than 0.005 mg/L (i.e., BH073 and BH076). Selenium concentrations in boreholes near the more southern lobe of MWD090 ranged from 0.018 mg/L to 0.032 mg/L (BH157, BH158, and BH167). However, selenium concentrations further downstream in boreholes BH169 and BH170 were less than 0.002 mg/L. Direct-push boreholes advanced near the more northern lobe of MWD090 contained groundwater with non-detectable selenium concentrations (<0.001 mg/L) consistent with the observation from MMW014. Similar to the northern area, selenium concentrations above the criterion of 0.05 mg/L are located beneath or very near the waste rock accumulations.

In addition to the alluvial groundwater flow toward Lone Pine Creek from the southern area, there is a potential component of alluvial groundwater flow from the relatively small waste rock areas located on the west side of the mine pits (MWD087). This potential alluvial flow is associated with a small tributary to Long Valley Creek. In addition, pre-mine topography suggests that some alluvial flow could originate in the headwater area from a portion of MWD086. This drainage was investigated with three boreholes (BH072, BH078, and BH079). Alluvial groundwater was scarce in this small tributary watershed with groundwater not encountered in two locations including the borehole advanced at the toe of MWD087. The one location where groundwater could be collected (BH079) had a non-detectable selenium concentration (<0.001 mg/L) (**Drawing 4-12**). This tributary drainage apparently does not contain any significant quantity of contaminant-impacted alluvial groundwater.

Two monitoring wells have been used to monitor the alluvial groundwater over time in the southern area – MMW010 and MMW014 (as noted above). Monitoring well MMW010 is located in the southern lobe of MWD086 near pond MSP014, and MMW014 is centrally located at the toe of waste rock pile MWD090 (**Drawing 4-12**).

Selenium concentrations in MMW010 exceed the criterion of 0.05 mg/L every spring with concentrations up to 0.219 mg/L, and all the fall results were below 0.05 mg/L when they measured prior to 2011 (**Figure 4-15**). It is notable that MMW010 has the only non-selenium groundwater exceedance at the Site. Cadmium exceeds the screening criterion of 0.005 mg/L on three occasions; however, the maximum concentration is only 0.00628 mg/L. Selenium concentrations in MMW014 are not detected or are very near the detection limit (**Figure 4-16**), and cadmium concentrations, similarly, have been at or below the detection limit.

Of the three (3) preliminary COCs identified in the BRA (arsenic, cobalt, thallium), MMW010 and to some extent MMW014 have some of the higher risked-based preliminary COC concentrations (**Drawing 4-12** and **Appendix B**, **Table B-7**). Both wells were sampled twice (fall 2007 and spring 2008) for a suite of constituents that contained the preliminary COCs.

FIGURE 4-15
TIME SERIES SELENIUM CONCENTRATIONS FOR MONITORING WELL MMW010

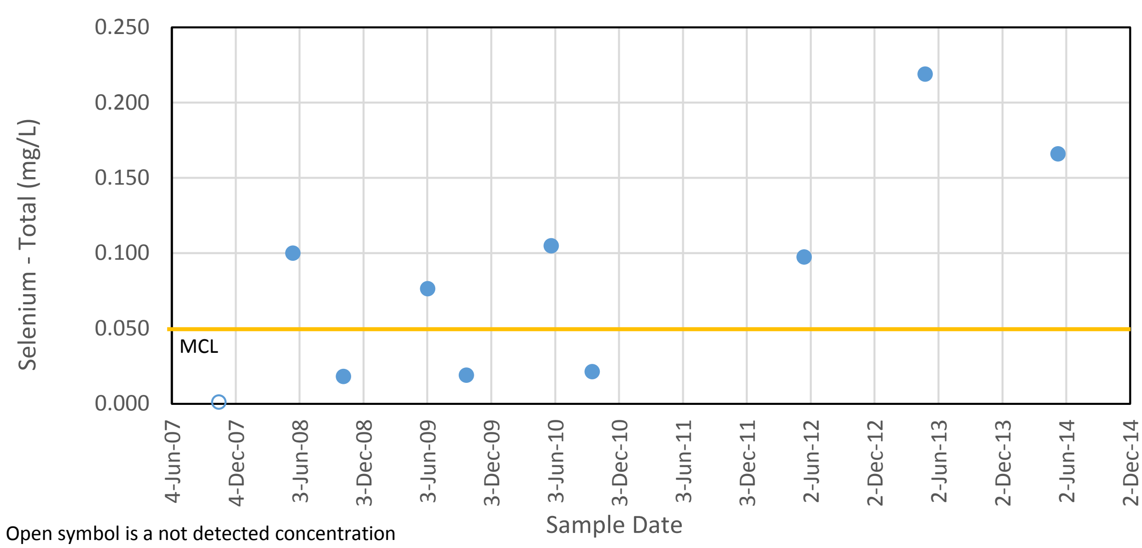
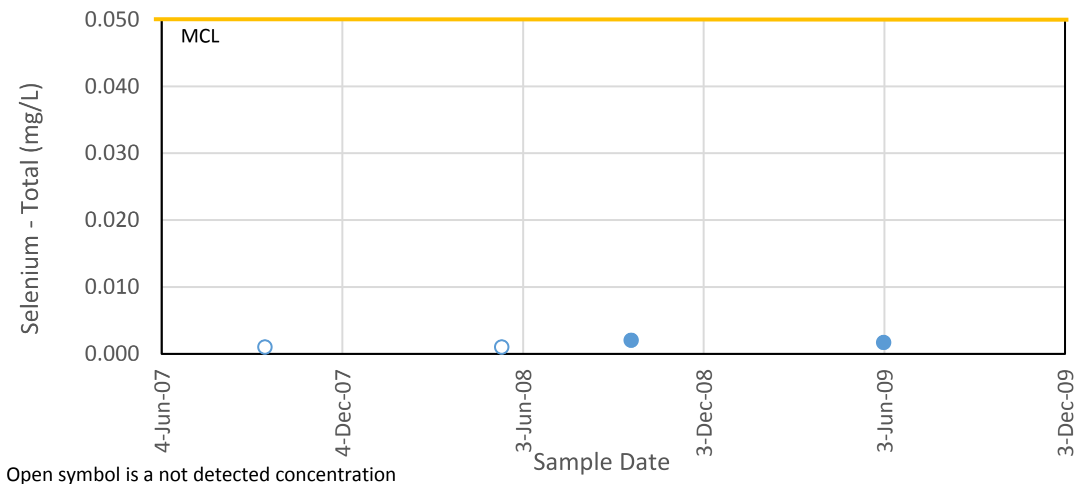


FIGURE 4-16
TIME SERIES SELENIUM CONCENTRATIONS FOR MONITORING WELL MMW014



Groundwater samples collected and analyzed from MMW010 have, (1) a detectable arsenic concentration of 0.0043 mg/L (spring) and no detection in the fall (<0.0005 mg/L), (2) a detectable cobalt concentration of 0.01 mg/L (the detection limit) in the fall and no detection in the spring (<0.01 mg/L), and (3) a detected thallium concentration of 0.0008 mg/L (spring) and no detection in the fall (<0.0001 mg/L). All of these spring-season sample concentrations exceed background concentrations (**Table 4-11**), and are consistent with the observation of elevated selenium in the well in the spring. The concentrations of arsenic, cobalt, and thallium are below applicable screening criteria.

Groundwater sampled from MMW014 reports arsenic concentrations ranging from 0.001 mg/L (spring) to 0.0012 mg/L (fall), no detectable cobalt (<0.01 mg/L), and no detectable thallium (<0.0001 mg/L) in the spring, but detected at 0.0009 mg/L in the fall. These concentrations are generally near to slightly above the background levels of 0.00103 mg/L arsenic, 0.000436 mg/L cobalt and 0.00002 mg/L thallium. The concentrations of all these preliminary COCs are below screening criteria[4].

With an exception of the first sampling event in October 2007 (36.7 mg/L), sulfate concentrations in MMW010 groundwater have been above the SMCL of 250 mg/L in every event, with a maximum concentration of 782 mg/L. This is also reflected in the TDS concentrations which range from 940 to 1770 mg/L (SMCL of 500 mg/L) with the exception of the October 2007 event (280 mg/L).

[4] Note that one sampling event for MMW004 in fall 2005 reported a method detection limits (MDL) for cadmium that exceeded its screening criteria. All other sampling events reported cadmium below a lower MDL in this well.

Here again, these results are consistent with the elevated selenium concentrations observed in the well, but the seasonality is less pronounced. Sulfate (less than 62 mg/L) in MMW014 is well below the SMCL. Well MMW014 has a higher proportion of alkalinity in the groundwater, and as a result the TDS is elevated with respect to sulfate ranging from 350 to 580 mg/L.

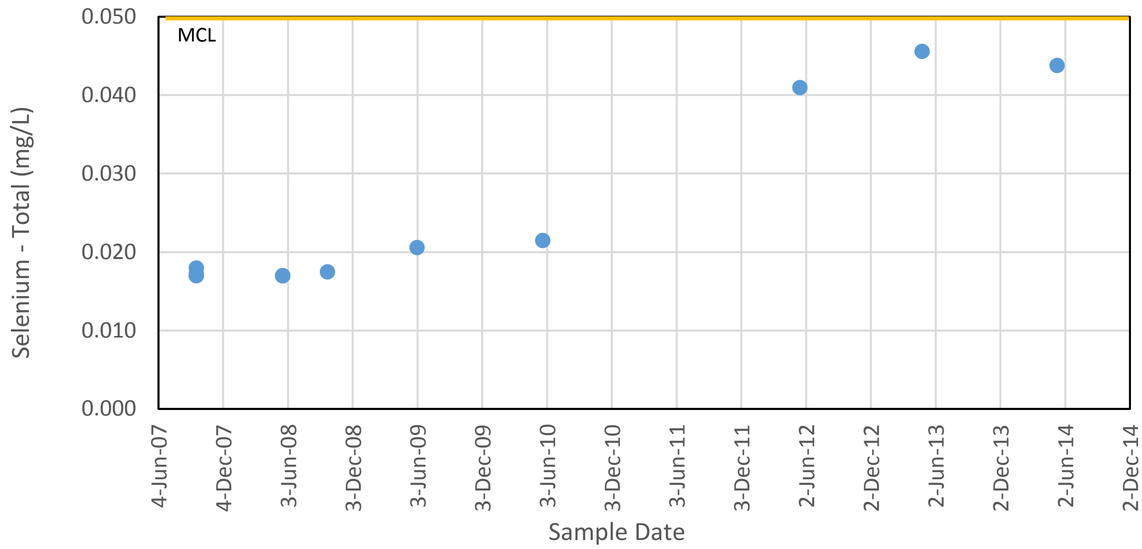
The MMW010 area is notably affected by elevated COC concentrations, and vertical hydraulic gradients and COC transport are a consideration. The nearest bedrock well is MPW023 located approximately 750 feet to the southeast in Phosphoria Formation, and COC concentrations do not exceed screening levels in this well as further discussed in Section 4.5.2.4. This lack of impact suggests that downward migration into the bedrock at this location is not occurring despite an apparent slight downward gradient indicated by comparisons of MMW010 and MPW023 water level measurements. Both wells are installed in mining disturbed areas, and adjacent to a backfilled mine pit, and while not collocated, they are in very similar positions relative to source materials and for assessment of alluvial groundwater conditions.

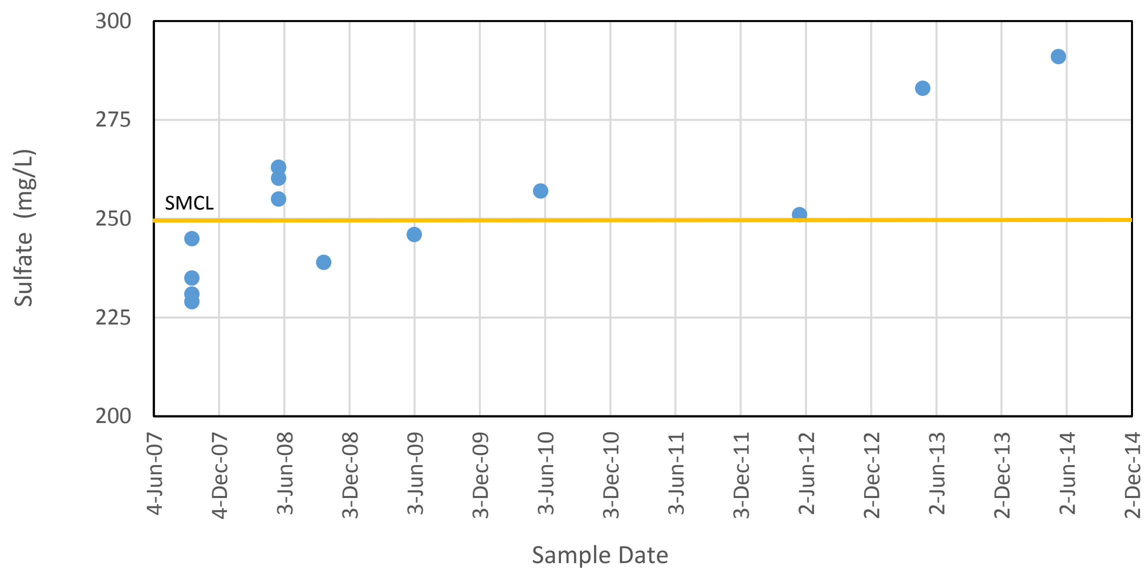
4.5.2.2 Dinwoody Formation

The Dinwoody Formation is exposed primarily on the ridge running along the eastern edge of the Site. This location is in the recharge zone for the Dinwoody Formation and any constituents from the Site that are present in the Dinwoody aquifer would be migrating parallel along the axis of the syncline toward the northwest and the Little Blackfoot River. However, some migration to the northeast toward the Henry Thrust Fault, perpendicular to the syncline axis also is possible (refer to Section 2.6 for further hydrogeology discussion). As a result, two monitoring wells were installed to evaluate these flow paths, MMW022 and MMW028 (**Drawings 2-2** and **4-12**).

Historical total selenium concentrations in groundwater sampled from monitoring well MMW022 are presented on **Figure 4-17**. Selenium concentrations were initially just less than 0.02 mg/L, but have increased to a maximum of 0.0456 mg/L (below the selenium criterion of 0.05 mg/L). In addition, sulfate concentrations have also increased with time being just above or below the SMCL (250 mg/L) for most of the sampling history, but having increased recently to as much as 291 mg/L (**Figure 4-17**). TDS has shown a similar increasing trend from 600 to 682 mg/L in April 2013, with maximum TDS concentration of 706 mg/L occurring in June 2009 (**Appendix B**, **Table B-7**). The significance of these trends are discussed in Section 5.0; however, this increase follows a large recharge event observed in 2011. Therefore, the elevated concentrations appear to be related to the uncommon recharge event (an advancing pulse) as opposed to an advancing plume. If the former is the case, then concentrations should decrease in future sampling rounds as the pulse migrates and dissipates and/or attenuates as it moves downgradient (i.e., assuming consecutive or closely spaced anomalously high recharge events do not occur).

FIGURE 4-17
TIME SERIES SELENIUM AND SULFATE CONCENTRATIONS FOR MONITORING WELL MMW022

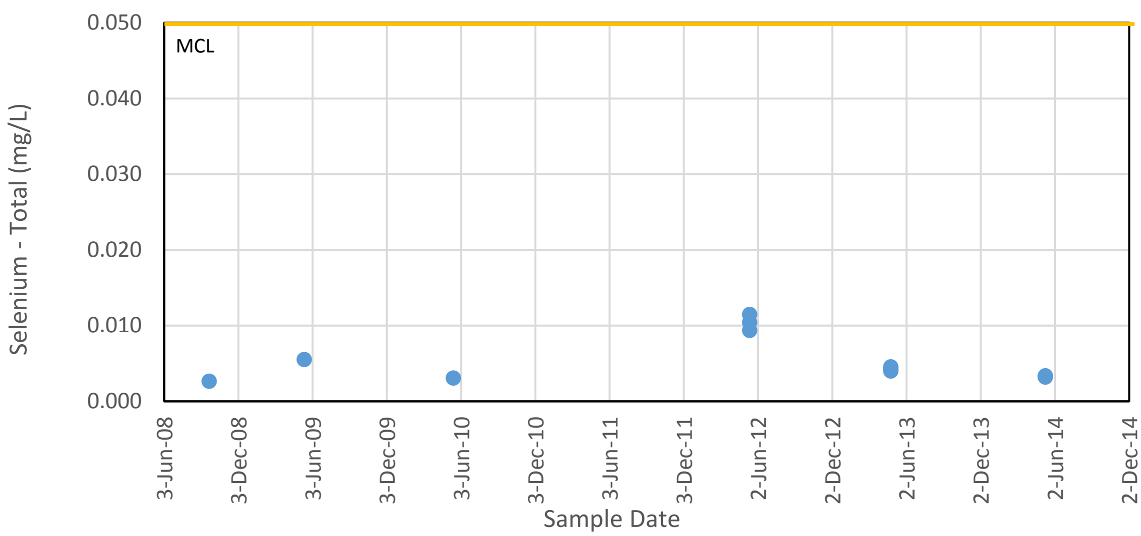




Historical total selenium concentrations in groundwater sampled from Dinwoody Formation monitoring well MMW028 are presented on **Figure 4-18**. Selenium concentrations in this monitoring well have been approximately 0.01 mg/L or less with a flat trend over the sampling record. This suggests that contaminant transport in the Dinwoody Formation toward the Little Blackfoot River is not a significant pathway. Sulfate reports a narrow low range of 65.25 to 72.8 mg/L in MMW028 groundwater, and TDS ranges from 294 to 484 mg/L with a sodium-chloride component (**Appendix B**, **Table B-7**).

Monitoring wells MMW022 and MMW028 were sampled once for the full suite of preliminary COCs. The three preliminary COCs identified in the Site BRA (arsenic, cobalt, and thallium) generally are not detected in the Dinwoody Formation wells (**Appendix B**, **Table B-7**). A single sample of a triplicate analysis reports an arsenic concentration of 0.0006 mg/L in MMW022 (below background level, **Table 4-11**). The other two samples have not detected concentrations at 0.0005 mg/L. Cobalt and thallium were non-detect in both monitoring wells. Concentrations along with the well locations are provided on **Drawing 4-12**.

FIGURE 4-18
TIME SERIES SELENIUM CONCENTRATIONS FOR MONITORING WELL MMW028

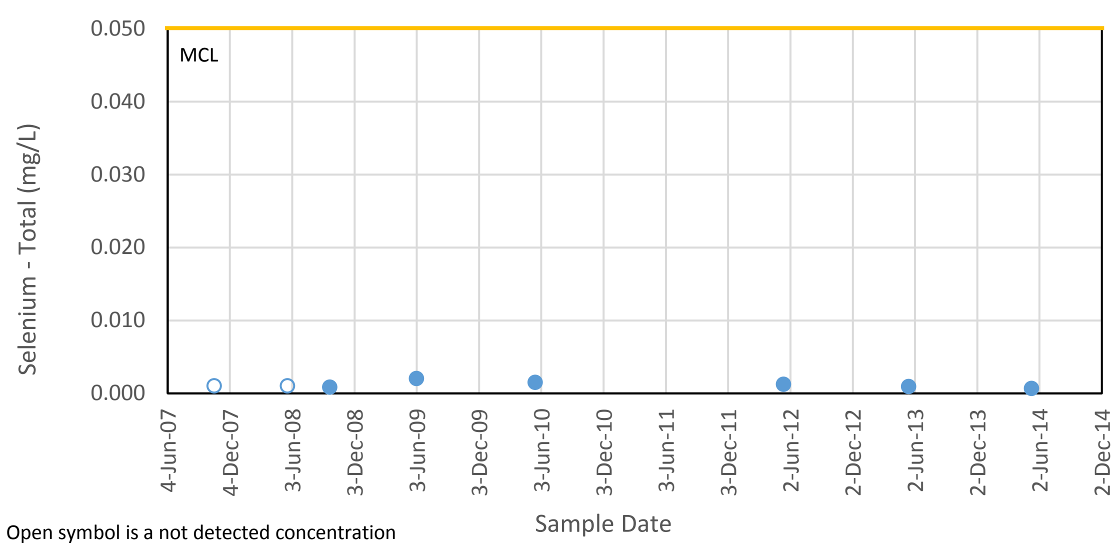


4.5.2.3 Wells Formation

The flow direction in the Wells Formation at the Site is predicted to be to the northwest toward the springs near the village of Henry (refer to Section 2.6 for the hydrogeology discussion). These springs are a recognized discharge location for the regional groundwater system that is composed primarily of the Wells Formation groundwater (MWH, 2008). Well MMW011 was installed to evaluate groundwater in the Wells Formation downgradient of the southern and central Henry mine pits. MMW023 was installed to evaluate groundwater in the Wells Formation directly beneath the northern mine pit (see **Drawing 4-11** for locations). Both wells have been sampled several times for selenium, but only once for preliminary COCs identified in the BRA.

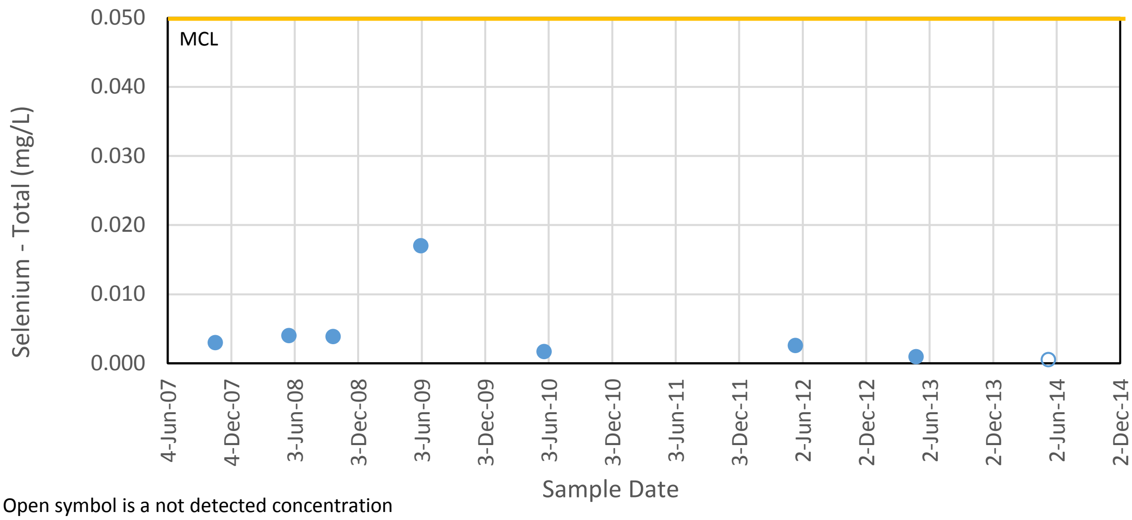
The historical groundwater preliminary COC concentrations for MMW011 and MMW023 are shown on **Figures 4-19** and **4-20**, respectively. With one exception (i.e., concentration of 0.017 mg/L in MMW023), selenium concentrations in both monitoring wells are below a maximum of 0.004 mg/L, which are below the selenium criterion of 0.05 mg/L. In the spring of 2009, the total selenium concentration reported in MMW023 is 0.017 mg/L. This may be the result of a larger recharge event. The effects of the recharge events dissipate rapidly in well MMW023. Unfortunately, sampling was not conducted in the spring of 2011 following the large 2011 recharge event noted in well MMW022 (above). The effects of the larger recharge events on preliminary COC concentrations in groundwater are discussed in more detail in Section 5.0.

FIGURE 4-19
TIME SERIES SELENIUM CONCENTRATIONS FOR MONITORING WELL MMW011



The selenium concentrations and other concentration data (e.g., sulfate) suggest that the Wells Formation monitoring wells are not significantly impacted by the Site. However, the preliminary COCs (Section 6.0) identified in the BRA (arsenic, cobalt, and thallium) are commonly detected in the Wells Formation (**Drawing 4-11**). Arsenic is detected in groundwater samples collected from MMW011 and MMW023 at concentrations of 0.0005 mg/L (the detection limit) and 0.0043 mg/L, and thallium at 0.0002 mg/L and 0.0009 mg/L, respectively. Cobalt is reported at the detection limit of 0.01 mg/L in MMW023, and is not detected in MMW011. These preliminary COC concentrations straddle the background threshold (**Table 4-11**).

FIGURE 4-20
TIME SERIES SELENIUM CONCENTRATIONS FOR MONITORING WELL MMW023



Open symbol is a not detected concentration

4.5.2.4 Other Hydrostratigraphic Units

Two production wells were installed in the southern portion of the Site during mining in the early 1980s. These wells were installed apparently in an attempt to help dewater the two southern mine pits. These wells, MPW022 and MPW023, are located just east and adjacent to mine pits MMP044 and MMP042, respectively (**Drawing 4-12**). Detailed drilling logs are not available for these wells. However, based on the geology and depth, and the MPW022 driller's log, these wells are likely installed in either the Rex Chert or Cherty Shale Members of the upper Phosphoria Formation. Because these wells were used for dewatering, it appears that they are in some hydrogeologic communication with the mine pits that are now backfilled and located near the wells. Given the geologic and topographic configuration, it is probable that they are in a downgradient position from the mine pits. Selenium concentrations in both wells typically are below the laboratory detection limits (**Figures 4-21** and **4-22**). Because both wells are located between the mine pits and the Lone Pine Creek watershed (**Drawing 5-3**), these data indicate that either mine-impacted groundwater is not present or the hydraulic gradient is not toward Lone Pine Creek. However, given the physical hydrogeologic configuration of the area, it appears that the wells are downgradient of the mine pits and upgradient of Lone Pine Creek.

FIGURE 4-21
TIME SERIES SELENIUM CONCENTRATIONS FOR MONITORING WELL MPW022

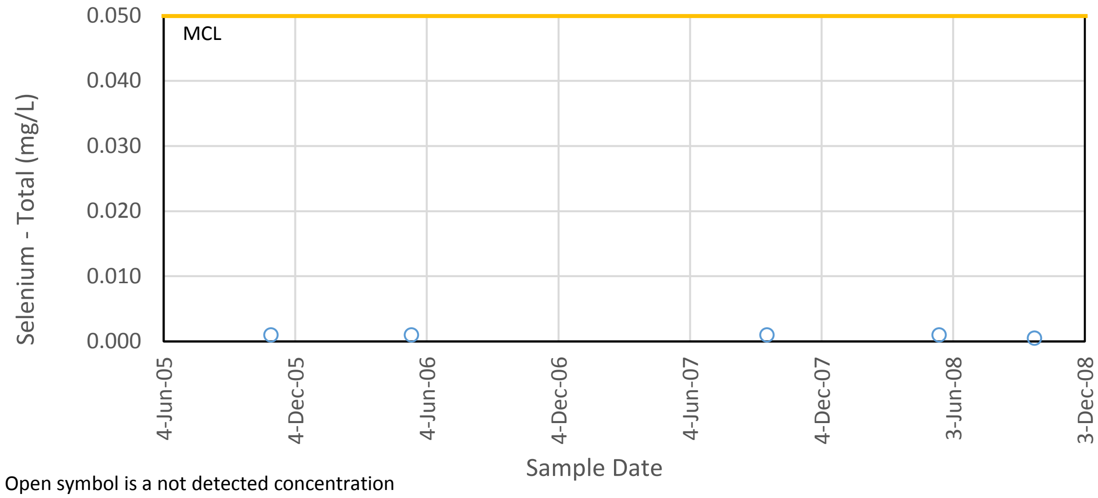
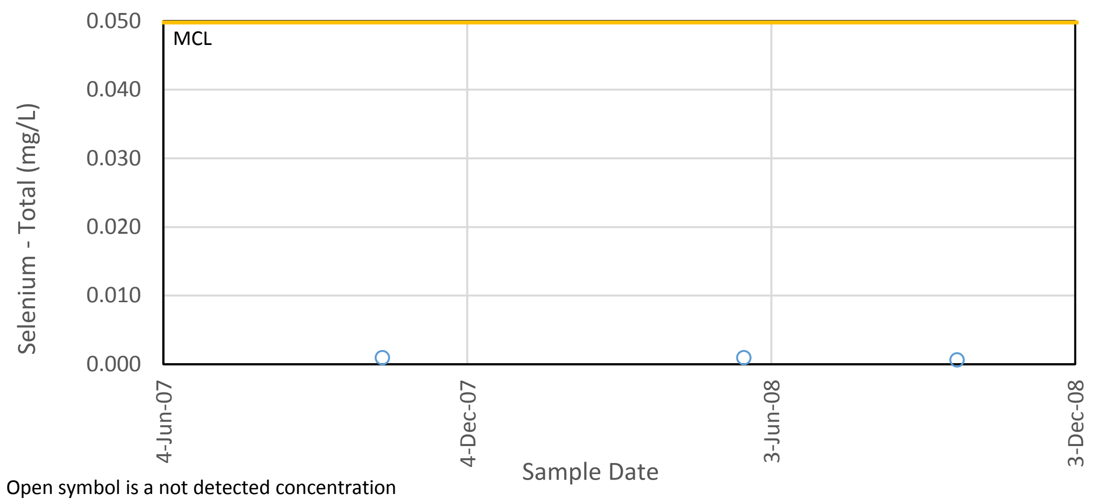


FIGURE 4-22
TIME SERIES SELENIUM CONCENTRATIONS FOR MONITORING WELL MPW023



Only groundwater collected and analyzed from MPW023 has detectable concentrations of the preliminary COCs identified in the BRA (i.e., arsenic, cobalt, and thallium). The results from the single sampling event shows arsenic at 0.0037 mg/L and thallium at 0.0005 mg/L (both above background threshold). Cobalt has never been detected at MPW023.

4.5.3 Water Quality Typing

Major ion data have been collected from groundwater monitoring locations during at least one pair of spring and fall sampling events for all monitoring wells, seeps and springs at the Site. The major ions include the cations: calcium, magnesium, potassium and sodium, and the anions: chloride, carbonate/bicarbonate (total alkalinity), and sulfate. Total alkalinity is used in place of carbonate/bicarbonate, because it is more commonly available in the data set. Where the forms of alkalinity have been analyzed, bicarbonate is the overwhelming predominant component of the total alkalinity as expected based on the pH of the samples, and all calculations assumed that total alkalinity is equivalent to bicarbonate.

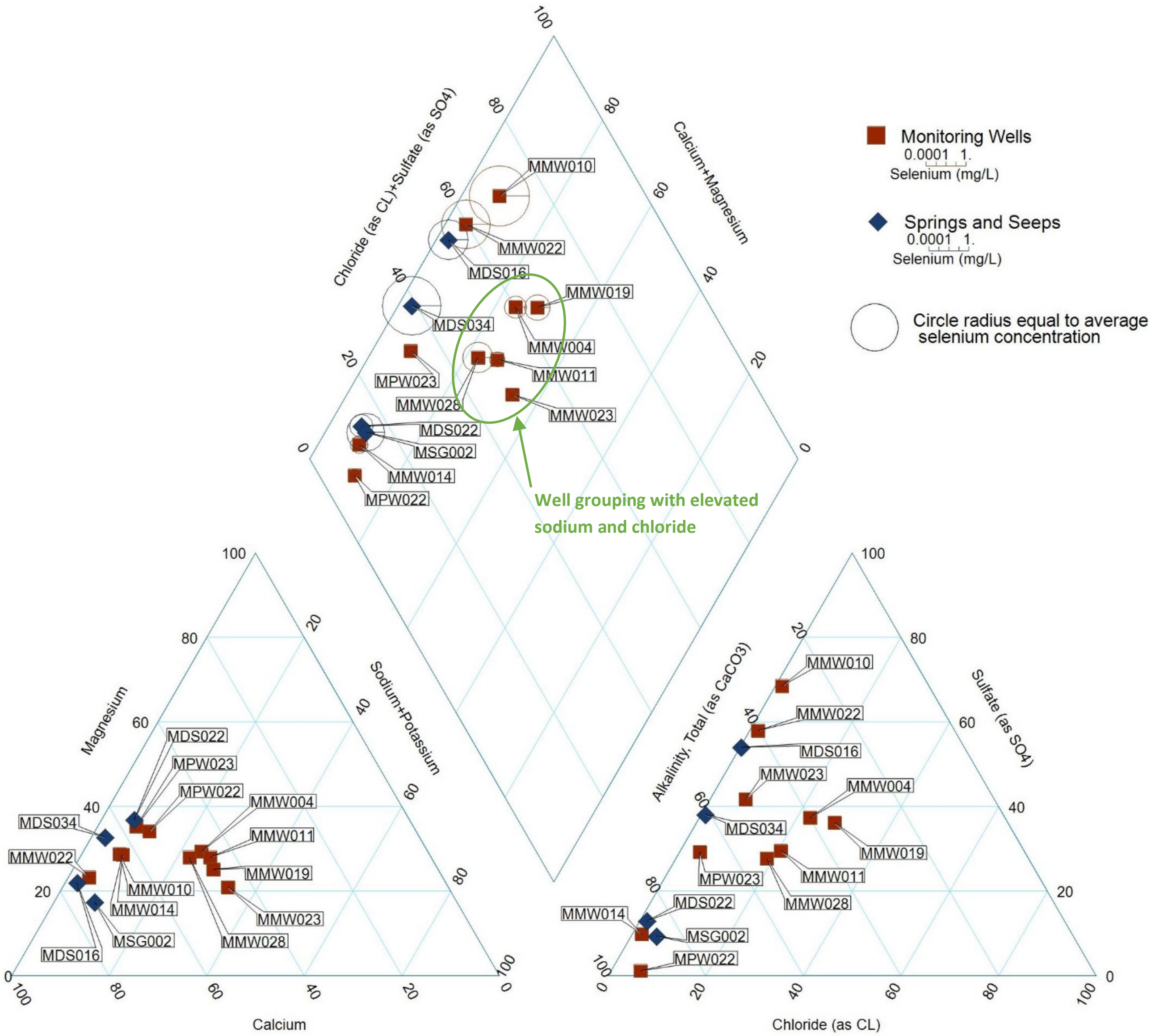
Piper diagrams are used to classify water types by comparing the ratios among the various ions. The major ion data are plotted on a piper diagram - **Figure 4-23** - to evaluate the overall water type and trends on the Site. All the available major ion data for the Site are averaged by location and plotted for clarity.

The Piper diagram indicates that the Site waters generally grade between a calcium carbonate/bicarbonate (carbonate) water type and a calcium sulfate (sulfate) water type. However, the monitoring wells in the northern portion of the Site also have a sodium chloride component, regardless of unit screened (i.e., MMW004, MMW011, MMW019, MMW023 and MMW028).

Selenium concentrations are plotted on the diagram as circles around the points with the radius of the circle proportional to the average selenium concentration for the monitoring location (the MDL is used for not detected concentrations). What is seen is that for those monitoring locations on the calcium carbonate – calcium sulfate trend, higher relative sulfate concentrations correlate to higher selenium concentrations. This is consistent with the conceptual geochemical model, discussed in detail in the *RI/FS Work Plan*, where oxidizing sulfides in the waste shales are a source of selenium. The correlation does not hold for the monitoring wells with the sodium chloride component. Besides having a higher relative sodium chloride component, there is also a higher relative sulfate component that does not correlate to higher selenium concentrations.

All the locations in the northern portion of the Site have relatively low concentrations of selenium. The source of the sodium chloride component ubiquitous to northern portion of the Site has not been determined. The unique features of this area include the basalt and the Little Blackfoot River.

FIGURE 4-23
PIPER DIAGRAM FOR ALL GROUNDWATER SAMPLING LOCATIONS INCLUDING SEEPS AND SPRINGS



4.5.4 Selenium Speciation

Wells MMW004 (northern alluvial) and MPW022 (Phosphoria Formation) were sampled in 2005 to evaluate the form of selenium in the groundwater and effects of sampling on the selenium speciation (see Section 3.7.3). A complete discussion of the results including quality control (QC) is reported in MWH, 2006. Extensive QC sampling was conducted to help validate the speciation sampling and analytical methods because of the uniqueness of the sampling program and analytical procedures.

The QC results were acceptable with the exception of low field spike recovery at the Site wells. However, the overall data were deemed acceptable for the study. **Table 4-13** lists the groundwater sampling parameters analyzed in the field, **Table 4-14** lists general metal/metalloid results, and **Table 4-15** provides the results of the selenium speciation analyses and field spike recoveries.

Results for two forms of preservation are presented (no preservation and EDTA preservation). All samples also were flash frozen in the field for transportation to the laboratory. The selenium speciation results identify that the field preservative used had minimal impact on the results signifying that interferences (possible co-precipitation after sample collection) associated with iron, manganese, and aluminum are negligible.

The speciated results were compared to a total selenium analysis and the relative present difference calculated. For monitoring well MMW004, the results were acceptable, but the selenium concentration in MPW002 was too low for a valid comparison. As described in MWH, 2006, the Henry and Ballard Site speciation results primarily validated the sampling method. The results do suggest that selenium primarily occurs as selenate (Se^{+6}) at the Site. This result would indicate that the selenium in the groundwater at the Site is in the most mobile form. However, the sample size was too small to develop any definitive conclusions, and the locations sampled had relatively low selenium concentration and are not indicative of a Site-impacted location.

4.5.5 Aquifer Solids

Aquifer solids were collected and analyzed during 2007 monitoring well drilling for chemical parameters from rock chip samples. Samples were either collected at the top of the borehole (at 5 feet), first water in the targeted unit or from the bottom of drill hole, or all three. These data are provided in **Table 4-16**. The rock samples from the Dinwoody and Wells Formations generally have lower concentrations of metals and a slightly alkaline pH (8 to 9 standard units or s.u.). The alluvial samples and the Phosphoria Formation samples generally have higher metals concentrations (chromium, iron, nickel, and selenium) and near neutral pH. The sample of Phosphoria Formation from MMW019 is not notably elevated in many of the constituents with the sample possibly from the Cherty Shale Member or a less mineralized interval of the Meade Peak Member. The MMW010 alluvial aquifer solids sample collected at first water (17 feet) had the highest concentrations of most metals including – cadmium, chromium, nickel, selenium, vanadium, and zinc. It is possible that at this location the alluvium was derived largely from the nearby Meade Peak Member outcrop. Alternatively, the elevated aquifer solid concentrations may be because of absorption from impacted groundwater. Either way, these concentrations could reflect or, in part, be associated with the elevated groundwater concentrations seen in the well.

4.6 BIOTA

A variety of aquatic biological-chemical data were collected during 2004 investigations at the Site. These aquatic data include: (1) stream habitat assessments, (2) riparian habitat assessments, (3) fish data, and (4) benthic macroinvertebrate data, which are discussed below. In addition, some terrestrial biota data were collected prior to 2004 including bird eggs, elk tissues and cattle tissues. However, these data have not been validated to current standards but can be validated, as needed, and used to support this RI and BRA. These data are extensively discussed in the *RI/FS Work Plan* and *DQUR/DAR*.

4.6.1 Habitat Assessments

Both stream habitat and riparian habitat were assessed for their functionality. These assessments are summarized below.

4.6.1.1 Stream Habitat Assessment

A stream habitat assessment was conducted in May 2004 on all streams influenced by the Site with the objective of differentiating stream habitat that supports fish from stream habitat that does not support fish. Rapid bioassessment surveys conducted on the streams used protocols established by USEPA (Barbour, et. al., 1999) to characterize the quality of the physical habitat. These results are reported in *Draft Interim Phase I SIs Evaluation Summary* (MWH, 2007) and *RI/FS Work Plan* and are summarized below.

The rapid bioassessment score (RBS) for each station was established by assigning ten categories a score of 0 to 20 points based upon field inspection as listed below.

- Frequency of riffles (or bends);
- Channel flow status;
- Embeddedness;
- Velocity and depth regime;
- Sediment deposition;
- Epifaunal substrate and available cover;
- Vegetative protection;

- Channel alteration;
- Riparian vegetative zone width; and,
- Bank stability.

The scores from the ten categories then were summed to calculate the RBS for each station. The maximum RBS is 200 points, with a high score indicating an overall high quality of physical habitat.

In addition to the RBS score, the presence or absence of fish at a station also was a consideration. The presence of fish was determined at each station by electroshocking. If fish were found, that is an unambiguous indication of the presence of fish. However, not finding fish is not an unambiguous indication of their absence. Thus, for those stations where no fish were found, but were bounded upstream and downstream by nearby stations on the same stream where fish were found, fish were assumed to be present. Of the 15 Site stations and four regional background stations included in the assessment, four Site stations and one regional background station were assumed to include fish using this logic.

Table 4-17 presents the RBS and fish presence at the Site area stream stations. To help understand the relationship between RBS and fish presence, also shown are surface water and sediment selenium concentrations from the corresponding sampling events. The locations of the stream stations evaluated are shown on **Drawing 2-1**.

Based on the 15 Site stations that were evaluated, the RBS ranged between 25 and 143. At the seven stations where fish were found (three stations) or presumed to be present (four stations), the RBS ranged between 52 and 143, and the RBS ranged from 25 to 56 for the eight stations where fish were not found. The four regional background stations reported RBS that ranged between 7 and 151, and fish were found at two stations (RBS of 103 and 151) and presumed to be present at one station (RBS of 139). With respect to the Site, fish were identified and higher RBS were obtained on the Little Blackfoot River. The other Site drainage evaluated for the presence of fish was Lone Pine Creek, with a lower RBS. No fish were found in Lone Pine Creek.

4.6.1.2 Riparian Habitat Assessment

Riparian habitat assessments, including evaluation of soil, vegetation, and species assemblages, were conducted on the riparian areas of ponds, springs, and non-fish-bearing streams at the Site in 2004. The sampling locations are presented on **Drawing 2-1**.

The riparian habitat assessments were conducted in two parts: one for ponds and one for seep, spring, and non-fish-bearing stream stations. The assessments were performed by a qualified ornithologist and fisheries biologist. As no regulatory or standard protocol could be found to fit the needs of this investigation, the ornithologist developed a detailed protocol. The stream habitat assessment described above was performed in the same stream reaches. Details of the procedures of both assessments, as well as the original presentation of the data, can be found in the *Draft - Interim Phase I SIs Evaluation Summary*.

The riparian assessment of each station began with a detailed observation of the area and then habitat use was recorded. Habitat use was described as the presence or absence of a particular assemblage of species, where each assemblage more or less represents a guild of species exploiting the habitat of interest in a similar manner. A statistical and ranking analysis was performed to classify the stations. For ponds, the rankings were as follows:

- Rankings #1 and 2 — high-quality riparian habitat
- Rankings #3 and 4 — low-quality riparian habitat

After the statistical analysis on the streams, it was determined that stations could be grouped into four distinct categories:

- Ranking #1 — high-quality aquatic and terrestrial habitat
- Ranking #2 — high-quality aquatic, but low quality terrestrial habitat
- Ranking #3 — low-quality aquatic, but high quality terrestrial habitat
- Ranking #4 — low-quality aquatic and terrestrial habitat

As part of the assessment, in September 2004 riparian soil and vegetation samples were collected for laboratory analysis. The resulting data matrices for ponds, springs, and streams at the Site are presented together in **Table 4-18**. This table presents observed or potential species use, soil and vegetation selenium concentrations, and habitat quality rankings.

As shown in **Table 4-18**, the majority of the riparian habitats were of low quality. Of 18 Site stations and two regional background stations assessed, nine were in the top two quality ranking categories. Soil selenium concentrations ranged from <0.5 to 45 mg/kg for all stations with the highest concentrations reported in ponds (12 to 45 mg/kg). Soil selenium concentrations in the top ranking (#1 and #2) for streams ranged from <0.5 to 4.3 mg/kg. Vegetation selenium concentrations ranged from <0.5 to 65 mg/kg. Again the highest concentrations were reported from ponds (3.3 to 65 mg/kg). Vegetation selenium concentrations in the top two rankings for streams were all <0.5 mg/kg.

Given the nature of these stream systems, interpreting ranking #3 and #4 as indicative of poor quality habitat may be inaccurate. These rankings may be indicative of a limited amount of habitat type present. Small streams simply do not generate much riparian habitat. Thus, the assessment of riparian habitats does not point to any such habitats being of poor quality due to potential Site impacts.

In addition to the 2004 assessment of ponds for riparian habitat discussed above, the IDEQ (supported by other regulatory agencies and P4) conducted a FUI of Site ponds, which included riparian habitat. The FUI established selenium action levels for the non-regulated surface water features (i.e., the Site ponds). The results of the FUI are presented in Section 4.4.2 (**Table 4-8**) along with the pond surface water data. Both assessments indicated that MSP014 was high quality habitat, and MSP015 and MSP055 were lower quality. Both assessments gave MSP055 the lowest possible ranking. Pond MSP016 was given the highest quality ranking by the FUI (Tier 1) and a lower ranking in the P4 study (**Table 4-18**).

4.6.2 Aquatic Biota

Attempts to collect both fish and benthic macroinvertebrates were made in the limited aquatic habitat present at the Site. These studies are summarized below.

4.6.2.1 Fish

Fish samples were collected from three Site and two regional background stream locations, all on the Little Blackfoot River or tributary, in 2004 to evaluate impacts of Site contaminants on fish in area streams. Forage fish were obtained from the stream stations; no salmonids were found. Samples of fish tissue were analyzed for five constituents: cadmium, nickel, selenium, vanadium, and zinc. Results of this investigation are included in the *Draft - Interim Phase I SIs Evaluation Summary*. **Table 4-19** presents the constituent concentrations found in forage fish in streams near the Site. The concentrations of selenium ranged from <2.4 to 6.1 mg/kg. The highest selenium concentration was detected at MST043 below the mine, which was the only constituent elevated in the fish sample collected from this location. The highest zinc concentration (230 mg/kg) was reported at MST053. Nickel (24 mg/kg) and vanadium (0.95 mg/kg) were the most elevated in background location

MST254 (upstream tributary), while cadmium results were similar in both the Site and background samples.

Attempts to locate fish at the other stream stations along Lone Pine Creek (e.g., MST054) as shown on **Table 4-17** were unsuccessful. This is likely the result of poor fish habitat at these stations due to physical factors (such as ephemeral streams), but may also be the result of other, including mining-related, factors.

4.6.2.2 Benthic Macroinvertebrates

This section presents the nature and extent of constituents in benthic macroinvertebrates at the Site. Samples were collected from 17 Site stream locations and four regional background locations (near Henry Site) during the 2004 sampling event to evaluate potential Site contaminant impacts on benthic macroinvertebrates in the area streams. The benthic macroinvertebrates samples were analyzed for selenium only, and the results of this monitoring event are presented in the *Draft Interim Phase I SIs Evaluation Summary* (MWH, 2007).

The selenium results for the 2004 benthic macroinvertebrate sampling event are presented in **Table 4-20**. Many of the benthic samples collected during 2004 have high MDLs as a result of low sample volumes (i.e., low numbers of macroinvertebrates), which are probably due to insufficient habitat as indicated by the stream habitat assessment and as a result of sample dilution in the laboratory. As discussed in Section 2.3, several stations are located along intermittent streams that during most years are completely dry by late summer so the numbers of macroinvertebrates would be expected to be low.

Of the 17 Site results, 15 of the results are flagged as non-detect (<1.3 to <130 mg/kg). Station MST057 reported a benthic macroinvertebrate selenium concentration of 6.2 mg/kg and MST276 reported a selenium concentration of 2.9 mg/kg. Both of these locations are located in the headwater area of Lone Pine Creek and have elevated surface water and sediment selenium concentrations as discussed in Sections 4.3 and 4.4. Regional background station, MST049, has a benthic macroinvertebrate selenium concentration of 3.8 mg/kg dw; the remaining three background stations are non-detect (<1.3 to <29 mg/kg).

4.6.3 Terrestrial Biota

A variety of biological-chemical data are available from the pre-2004 period. This includes the elk tissue, bird egg, and cattle biotic tissue data. The results for the elk tissue and bird egg data are not unique to a particular mine. The cattle data were collected at Henry Mine. The Henry Mine cattle study expanded on an existing study that was being conducted on reclaimed waste rock dumps at the mine. The scope was expanded to include characterization of selenium concentrations in surface soil and vegetation and also included steer blood and serum sampling. More detailed information on cattle tissue, the elk tissue, and bird egg data is found in the *DQUR/DAR* and the *RI/FS Work Plan*. These data, if useful, may support the human and ecological risk assessments summarized in Section 6.0. In addition, terrestrial biota data also are available for various small mammals and terrestrial invertebrates (MWH, 2002b).

5.0 CONTAMINANT FATE AND TRANSPORT

This section describes the fate and transport processes for the Site preliminary COCs/COECs[5]. The three subsections and their content are listed below.

- Section 5.1 – potential pathways of contaminant transport for the various media.
- Section 5.2 – contaminant characteristics, fate and mobility in the environment.
- Section 5. 3 – Site-specific preliminary COCs/COECs migration in the environment.

This section utilizes the data collected during the RI to evaluate fate and transport within the primary areas of identified contamination within and adjacent to the Site.

5.1 POTENTIAL PATHWAYS OF CONTAMINANT TRANSPORT

The objective of this section is to describe the physical and chemical transport pathways for each of the primary media investigated at the Site. These pathways then are discussed in more detail in Section 5.3 (Migration Assessment), which along with the contaminant characterization data presented in Section 4.0 provides a comprehensive picture of the contamination at the Site that will need to be addressed in the FS.

In addition, the transport pathways discussed herein are incorporated into the Site conceptual models that address the overall contaminant release and migration to potential receptors, which are presented in the BRA in Section 6.0 and Appendix A. The subsections below only discuss the release mechanisms and physical routes of migration whereby contaminants may move away from the source areas in a generally downgradient direction to their current limits and may potentially be transferred to other media in the process. The final stage of migration, the uptake by the receptors, is evaluated in the Henry BRA in Appendix A.

5.1.1 Upland Soil/Waste Rock and Vegetation Transport Pathways

Upland soil/waste rock and vegetation are generally static at the Site except where subjected to mass movements or erosion. Contaminants associated with upland soil/waste rock can be taken up by vegetation. The converse also is true, as once the plant dies it decays and is incorporated back into the soil. Because of their close physical and cyclic association on the Site, they are considered together in this section.

---

[5] COC/COEC(s) are generally synonymous with the generically used term contaminant(s) herein.

5.1.1.1 Upland Soil/Waste Rock Pathway

On the Site, upland soil/waste rock transport may refer to transport of the cover soil off of the reclaimed mine areas, but rarely, soil transport also may refer to the direct transport of mine waste rock or other types of contaminated soil like that used as road base. The term "soil" as used here therefore captures a wide variety of loose geologic materials.

The soil transport pathway was characterized by sampling of the upland soil/waste rock as presented in Section 4.1, which included the results of studies evaluating movement of contaminants from the reclaimed mine waste rock dumps onto native ground. The most decisive of these studies was the 2014 radiological investigation that demonstrated very little, if any, physical or chemical transport of material or contaminants from the mine waste rock dump soil to the surrounding native ground. A potentially more significant component of transport is channelization and transport of soil as sediment in stream channels leading away from the Site with associated possible contamination of the adjoining riparian soil. The distinction has been made here that once "soil" is being transported by moving water in channels, it has become sediment, which is discussed in Section 5.1.2 below.

Where not being transported as sediment in channels, the physical transport of soil/waste rock from potential source areas can occur via two general mechanisms:

- Mass Wasting[6]
- Erosion[7]

Visual evidence of mass wasting is not observed at the Site except in the unbackfilled mine pits where it is contained within the mine pit and is largely inconsequential to contaminant transport. Because of the regrading of the existing mine dumps and establishment of vegetation on the covered surfaces, no unreclaimed, angle of repose, mine waste rock dump slopes are present in exterior areas of the Site that would be more readily prone to mass wasting. Furthermore, the sampling studies presented in Section 4.1, which evaluated the waste rock dump perimeters, support the visual assessment that mass wasting is not a significant pathway at the Site.

---

[6] Mass wasting is a general term for "*the dislodgement and downslope transport of soil and rock material under the direct application of gravitational body stresses*" (Bates and Jackson, 1987).

[7] Erosion is the *"general process or group of processes whereby the materials of the Earth's crust are loosened, dissolved or worn away, and simultaneously moved for one place to another, by natural processes, which included weathering, solution, corrosion, and transportation"* (Bates and Jackson, 1987).

Erosion by water is more relevant at the Site. Erosion by water as direct precipitation and/or runoff is the primary mechanism of soil erosion at the Site. The unchannelized overland transport of soil/sediment by surface runoff is generally limited to short distances, if any, from the waste rock dumps as supported by the upland soil/waste rock data presented in Section 4.1. In addition, the majority of the waste rock source at the Site was placed as pit backfill and most of the external waste rock dumps are located between the two ridges discussed in Section 2.1. Therefore, the areas where mass wasting or overland sheet-flow water erosion potentially could transport soil/sediment off the waste rock facilities mostly are limited to the southern portion of the Site in the headwater of Lone Pine Creek and along the Little Blackfoot River in the northern portion of the Site (**Drawing 2-1**).

There is not significant evidence that wind erosion has any major role at the Site, nor would this be expected due to the regraded and well-vegetated surfaces present at the Site.

5.1.1.2 Upland Vegetation Pathway

Plant uptake of preliminary COCs/COECs from soil is not a physical pathway for transport of contaminants away from the Site. Plants are not harvested on the Site. The exception is potential livestock or wildlife grazing uptake. These processes associated with livestock and other potential exposure pathways to human and ecological receptors is further discussed in the overall Site conceptual models in the BRA (**Appendix A** and Section 6.0).

For vegetation growing near, but off of the waste rock dumps, uptake of contaminants remains low because soil contamination off the dumps is generally not present. A minor amount of contaminated plant matter may be transported away from the Site as sediment similar to soil. This matter is incorporated with the mineral matter and is evaluated as simply sediment (below).

5.1.2 Riparian Soil and Sediment Pathways

Downstream riparian soil and sediment locations were evaluated in association with most Site surface water locations and drainages. At those locations where water movement is slow or relatively stagnant in areas such as ponds, seeps and springs, contamination of the sediment and adjoining riparian soil is likely to be through chemical processes (precipitation or absorption from the water column). However, a pond also can act as a sediment trap for surface water carrying contaminated sediment, which then can result in a physical accumulation of contaminated sediment in the pond bottom. The mechanism for contamination associated with moving water can be the physical transport of sediment or through chemical processes.

Regardless of the mechanism, the processes of contamination of sediment and riparian soil are not going to be significantly different at the Site other than riparian soil is likely to be more static. Therefore, consistent with previous RI sections, these media are jointly considered here. The processes of sediment and riparian soil contamination at the Site are presented below.

5.1.2.1 Riparian Soil and Sediment Chemical Pathway

Dissolved contaminants released from sources can be transported through the surface water and groundwater systems and affect sediment and riparian soil. The surface water or groundwater may interact with sediment and riparian soil, at seep and spring discharge locations or in ponds. It is in these locations where reduction-oxidation (redox) conditions may change due to aeration (e.g., seeps) or biotic reduction (e.g., stagnant ponds). Changes in redox conditions or pH may result in enhanced contaminant precipitation or adsorption. These are attenuation processes that reduce the dissolved aqueous concentrations of contaminants, but may therefore increase sediment concentrations. These same chemical processes also may affect downstream sediment and riparian soil in streams, but it is difficult to distinguish these chemical attenuation processes from the physical transport and attenuation processes discussed below (without specialized studies).

5.1.2.2 Riparian Soil and Sediment Physical Pathway

The potential for physical off-mine contaminated sediment transport was limited by the mining/environmental practices at the mine. Sediment retention basins or berms were placed below the waste rock dumps, and these are still present below MWD085, MWD087, MWD088, and MWD090 (**Drawing 5-1**). The Enoch Valley haul road also functions as a sediment control feature for the waste rock that was placed to the south and uphill of the road. In addition, the Site was concurrently reclaimed during mining. Incrementally, as mining was completed, the associated mine waste rock dumps were regraded to relatively low-angle slopes, cover material was placed, and the mine dumps were seeded for revegetation. This practice greatly reduced the potential for erosive surface water channel development and for the transport of large quantities of sediment in stormwater that then leave the Site.

Only three small but notable erosional channels in the cover material have been observed: (1) the north-central portion of MWD088 (**Drawing 5-1**, **Detail A**), (2) on MWD090, near the northwestern end, west of the haul road (**Drawing 5-1**, **Detail B1**), and (3) on the eastern lobe of MWD090, both north and south of the haul road (**Drawing 5-1**, **Details B2** and **B3**). While these minor features are present, they have not been observed to contribute significant sediment to areas off the waste rock dumps. The sediment retention basins and berms provide some assurance that the sediment from these features has not been transported downstream. In addition, in their current state, based on vegetation in the features, the erosional channels do not appear recent.

While the chemical and physical pathways for sediment and riparian soil are complete at the Site, they appear to be limited in their ability to transport contaminants off the Site. However, the chemical pathway for sediment and riparian soil contamination is not similarly restricted. The aqueous chemical pathway that could result in ongoing sediment and riparian soil contamination is discussed below.

5.1.3 Surface Water Pathways

Transport of contaminants from potential source areas to Site stream systems occur via two mechanisms:

- Stormwater runoff - overland runoff due to precipitation or snowmelt, which is ephemeral.
- Groundwater discharge to the ground surface via dump seeps, springs, or into the stream bed and thereby into surface water, which can result in perennial stream flow.

5.1.3.1 Stormwater Runoff Pathway

Overland flow or shallow interflow that surfaces on the lower slopes of waste rock dumps can occur during heavy rains or, more commonly, during the spring snowmelt. This can result in stormwater runoff moving off the mine in small ephemeral surface water channels that adjoin the waste rock dumps. Stormwater runoff is limited at the Site by the physical location of the mine pits and the waste rock dumps between ridges and the sediment control basins. Higher flows are observed in the spring, but concentrations of contaminants are not notably elevated in Site surface water during the spring sampling events, suggesting that runoff is not a large contributor to sediment transport (Section 4.4). The direct stormwater runoff pathway is marginally complete at the Site, but is not as significant at the Henry Site as at some other phosphate mining Sites (e.g., the Ballard Site) because of the reclamation practices that were utilized during closure of the mine.

If any contaminated overland flow leaves the Site, it is limited to the where the Little Blackfoot River passes through the Site; the upper, western, portion of the Lone Pine Creek watershed; or to a small tributary to Long Valley Creek on the west side of the Site (**Drawing 2-1**). However, as noted, the sediment basins/berms mitigate the potential for stormwater runoff reaching the watershed.

5.1.3.2 Groundwater Discharge to Surface Water Pathway

Another conceptual pathway for contaminants released from the mine is infiltration of precipitation or snow melt through a waste rock dump and discharge to down slope stream channels as discussed below. Contaminants dissolve from the waste rock into infiltrating precipitation and then are transferred to surface water (1) via discharge of mine dump-derived "perched" groundwater from seeps or (2) due to continued downward migration of precipitation through the waste rock dumps and into shallow alluvial groundwater. This shallow groundwater then resurfaces downgradient as springs or directly into the stream bed or pond, which are in contact with the groundwater. It should be noted that in some cases there is a reversal in this pathway and surface water can affect shallow groundwater. However, because the contaminated alluvial groundwater typically follows a subsurface pathway that coincides with surface water channels, the distinction between cause and effect is often not clear and may change by season.

Rainfall or snowmelt that infiltrates into the waste rock dump can percolate through the dump, follow preferential flow pathways as groundwater, and exit the dump often at the margins as seepage. Such seeps without a deeper groundwater source tend to be ephemeral and respond to the timing and size of the snow melt or precipitation event. Seeps of this nature often are associated with poorly reclaimed dumps where poor vegetative cover helps facilitate rapid infiltration and percolation. Because the Site waste rock dumps are well graded and vegetated, this has reduced the number and discharge volume of such seeps. However, dump seeps MDS016 and MDS034 at the Site are short-term ephemeral seeps that appear to be dominated by perched groundwater flow through the dump material originating from spring snow melt (see Section 2.3.2).

Seeps also may occur under different conditions, where waste rock dumps have been built directly on pre-existing springs or existing drainage channels. In this case, often the bottom of these waste rock dumps may have higher permeability; thus, when a waste rock dump is placed over a spring or pre-existing stream channel, water is readily able to flow through the material and transport contaminants through the waste rock to a discharge point, typically at the toe. Seep MDS022 below MWD090 appears to be such a seep.

The history of this seep is unknown, but it discharges from a "limestone drain". Such a drain was probably constructed during waste rock dump construction to channel water from an existing spring or wet area from beneath the dump. This seep has perennial discharge characteristic of a groundwater source (Section 2.3.2). In addition, spring MSG002 has perennial discharge and appears to have been a preexisting spring that now is affected by impacted groundwater as discussed in Section 5.3.

5.1.4 Groundwater Pathways

The groundwater systems found at the Site are discussed in Section 2.6, and details of the general groundwater flow systems typical of the P4 Sites are presented in the *RI/FS Work Plan*. This section summarizes the relevant hydrogeologic configuration and pathways at the Site that affect contaminant transport.

Groundwater is one of the primary transport media where elevated contaminants from the Site can move towards off-site receptors. It is also the most complex and difficult to characterize with multiple pathway variations that are not directly observable. The investigations during the RI focused on pathways most likely to be affected by Site contamination in each groundwater flow system (alluvial, Dinwoody Formation, and Wells Formation systems). This resulted in a phased investigation of potential pathways and identification of those pathways requiring additional investigation during the RI. All three of the primary groundwater flow systems are present and relevant to the Site. The Dinwoody and Wells Formation groundwater flow systems are affected by the underlying geologic structure including folding, fault and factures in the bedrock.

As a result of the geologic and topographic setting (presented in Sections 2.1 and 2.4) and the placement of the mine pits and waste rock dumps, any contaminated alluvial groundwater flow is directed primarily to the northwest or the southeast in the trough between ridges. This flow is interrupted where there are breaks in the ridges that allow the shallow groundwater to flow toward the Little Blackfoot River or Lone Pine Creek. Deeper groundwater flows generally along bedrock bedding planes, primarily to the northwest toward the Henry Springs discharge area (refer to **Drawing 2-2**). The details of the groundwater contaminant transport pathways for each of the flow systems are presented in the following subsections.

5.1.4.1 Shallow Alluvial Groundwater System

The stratigraphy within the alluvial unit is relatively complex with interfingered lenses of materials ranging from silts/clays to gravels that pinch out both vertically and horizontally. These layers often have widely ranging hydraulic conductivities (as presented in Section 2.6). The bulk of contaminant transport may occur in one or a few relatively thin higher permeability layers (e.g., sandy or gravelly units). In addition, this same layering of sediment likely helps inhibit the vertical migration of potential contaminants by preferentially moving groundwater horizontally in high permeability layers (while inhibiting the downward migration because of fine-grained lenses of silts and clays).

Since the shallow alluvial groundwater system often directly underlies the waste rock dumps, the alluvial system is most likely to be impacted by seepage from the waste rock dumps, and in most cases, provides the most direct link to potential receptors, whether it be through seep and spring flow, discharge to nearby creeks, potential plant uptake, or through groundwater extraction for livestock watering. Often the vertical permeability of the alluvial system is substantially lower than the overlaying waste rock, which leads to some waste rock seepage being expressed as seeps at the margin of a waste rock dump. Flow through the alluvial system also may pass to other groundwater flow systems via vertical (i.e., downward) percolation, but as previously noted, vertical migration is less favored due to lower vertical permeability.

At the Site, waste rock was placed over large areas of alluvial deposits in the swale between bedrock ridges as discussed in Section 2.1 and 2.4, so this pathway is of primary importance at the Site. Transport from open or backfilled mine pits to the alluvial system at the Site is not considered a complete pathway.

Alluvial groundwater systems primarily exist in two locations at the Site: (1) Northern Alluvial Area located on either side (north and south) of the Little Blackfoot River, where the river crosses through the Site, and (2) the Southern Alluvial Area, located in the western headwater area of Lone Pine Creek in the southeastern portion of the Site (**Drawings 2-2** and **4-11**). Only in these two areas identified above, does the alluvial system daylight from beneath the waste rock. Flow direction and gradient in these relatively thin alluvial flow systems follows the relatively flat topography of the area toward the surface water features, notably the Little Blackfoot River and Lone Pine Creek. The contaminant migration in the shallow aquifer is discussed in Section 5.3.4.1.

Shallow Groundwater Transport to Surface Water

This pathway is described in Section 5.1.3.2 (Groundwater Discharge to Surface Water Pathway) above.

5.1.4.2 Dinwoody Formation Groundwater System

The Dinwoody Formation (discussed in Section 2.4) typically hosts either local or intermediate groundwater flow systems. An intermediate system has the recharge area in one basin and the discharge area in the adjacent basin. The Dinwoody Formation at the Site has the potential to act as both a local and intermediate flow system.

At the Site, the Dinwoody Formation flow system either underlies the alluvial system beneath the waste rock dumps (Section N-N’, **Drawing 5-3**), or directly underlies the waste rock in some areas without significant intervening alluvial material (**Drawing 2-2** and Section B-B’, **Drawing 2-3**).

It is possible that percolation through mine pit backfill could enter the Dinwoody Formation flow system exposed in upper portions of a pit wall. In order for seepage from the bottoms of the mine pits to flow to and recharge the Dinwoody Formation, it would have to flow across bedding through the Phosphoria Formation and into the Dinwoody Formation. The Phosphoria Formation has a low hydraulic conductivity perpendicular to bedding and is generally an aquitard; therefore, seepage from water contained in the mine pits is unlikely to impact the Dinwoody Formation. This is not considered a complete flow path.

Contaminated external waste rock dump seepage entering the Dinwoody Formation either directly or from the alluvial system forms complete flow paths. Complete flow paths largely occur on the northwest side of the Site, where flow along bedding may occur to the northwest (a local system), or to the Henry Thrust Fault through the ridge to the northeast (an intermediate system). Flow toward the Henry Thrust Fault would be along and across bedding because of folding. Therefore, the flow path along bedding to the northwest appears to be a path of least resistance and the more likely flow path.

5.1.4.3 Wells Formation Groundwater System

The Wells Formation generally is considered to host intermediate and/or regional groundwater flow systems. The recharge areas for a regional flow system may be separated from the discharge areas by several topographic highs and be overlain by both local and intermediate groundwater flow systems. The Wells Formation outcrops to the southwest edge of the Henry Mine, adjacent to the highwall that is common to all of the Henry mine pits. The ridge to the southwest of the Henry Mine, which is underlain by Wells Formation (**Drawing 2-2**) is an area of known recharge to the Wells Formation (Brooks, 1982).

Henry Springs, located just northwest of the Site, is the discharge area most likely to receive any Wells Formation water affected by the Site (**Drawings 2-1** and **2-2**). Henry Springs are located at the intersection of the normal Slug Valley Fault and the Henry Thrust Fault. These faults are affecting and focusing regional groundwater transport and discharge in the area, and Mayo (1982) and Ralston, et al. (1983) have identified the Henry Springs area as a major location of discharge from the regional Wells Formation aquifer. Furthermore, a major strike-slip fault with as much as 4,000 feet of lateral displacement is located just south of the South Henry mine pit (**Drawing 2-2**). This fault, the Rasmussen Fault, is most likely a flow barrier that limits groundwater movement to the south. In addition, antidotal evidence indicates that water levels in the Wells Formation in the southern portion of the Henry Mine near the Rasmussen Fault are as much as 200 feet higher than at MMW011, as discussed in Section 2.6.2.2.

Thus, the Wells Formation at the Site is contained within a structural block bounded by the Henry Thrust Fault on the east and north, the Slug Valley Fault on the west and the Rasmussen Fault on the south (**Drawing 2-2**). The combination of these features and the orientation of the Wells Formation bedding focuses the deeper Site groundwater flow to the northwest and towards Henry Springs as illustrated in **Drawing 2-2**. This flow direction is supported by Site data, specifically the piezometric levels in monitoring wells MMW011, MMW023, and at the Henry Springs (see Section 2.6.2.2).

Recharge of contaminant-affected water to the Wells Formation flow system could occur in either open or backfilled mine pits, which would then flow towards Henry Springs. Any such affected recharge initially would be restricted to the upper Wells Formation beds near the contact with the overlaying Phosphoria Formation. In addition, as discussed in Section 5.3, other factors appear to reduce the importance of this pathway.

5.1.4.4 Structural Flow System

The groundwater flow systems and pathways are affected by faulting and/or local and regional fracturing that can influence the local, intermediate, and regional flow systems, depending on how extensive the structures are. Faults may act as flow barriers or conduits and, in some cases, may act as both. For example, thrust faults typically have a low permeability gouge zone that acts as a flow barrier; however, there may be significant fracturing adjacent to the actual fault that increases permeability along the thrust fault.

The Rasmussen Fault, located south of the southern portion of the Henry Mine (**Drawing 2-2**), is a large east-west trending lateral slip fault that displaces the bedrock units and offsets the surface expression of the Wells Formation. This bounding feature is discussed above in association with the Wells Formation.

The Henry Thrust Fault on the northeast side of the Site (**Drawing 2-2**) is another relevant structural feature. Flow along this feature would be to the northwest toward Henry Springs, and as discussed above in association with the Wells Formation, apparently focuses bedrock groundwater flow towards Henry Springs.

Within the Site, a potential east-west trending structure was considered. On the northern end of the Henry Mine, between MMP041 and MMP043, there is a gap in the ridge and an apparent deflection in the geologic units. The Little Blackfoot River flows through this gap. There are no significant faults mapped at this location, as suggested by both the gap and apparent deflection in the geologic units. The potential presence of a structural feature such as a fault acting as a flow barrier or conduit was discussed in MWH (2008). This was further evaluated by tracking the hydrologic responses of MMW011 and MMW023 installed in the Wells Formation on either side of the possible structure. The results of this analysis are inconclusive. However, given the overall structural setting of the Wells Formation in the Site, the presence of this potential fault would not be expected to have a significant impact on the overall flow pattern given only a very slight apparent offset of the Wells Formation.

Other minor faults have been mapped in the mine area cutting perpendicular to strike through the Wells Formation and Meade Peak Member. These frequent faults show relatively minor displacement, are narrow fractures, and are likely only present locally. Such small faults and fractures contribute to the bulk hydrogeologic character of the bedrock unit and should be characterized as a component of the overall hydrostratigraphic unit. None of the aforementioned faults or suspected faults, which generally cut across the structural general trend of the Site, appear to be complete flow paths.

The most significant structural feature in the Site area is the syncline that is located between the mine and the Henry Thrust Fault and is associated with the fault (i.e., the fold formed along with the thrust faulting). Synclines tend to have groundwater flow in the direction of the syncline axis. This flow path then would be parallel to the mine in the southeast-northwest trend and has a pronounced influence on groundwater flow in all the flow systems as discussed throughout this section. This even includes the alluvial system because the syncline formed a trough that localized the deposition of alluvium on the Site. The syncline is a significant flow path related to the structure of the Site, but it is primarily addressed in association with the individual flow systems.

5.2 CONTAMINANT CHARACTERISTICS, FATE, AND MOBILITY

Chemical elements that originate at the Site are derived primarily from the waste rock associated with the phosphate ore as discussed in Section 2.10. The specific contaminants that have been detected and the media and locations where they are present are discussed in Section 4.0. The Site contaminants are inorganic, existed in the environment prior to mining activities, and in most cases are persistent in the environment. They do not decay or transform to other elements. However, the Site contaminants may change their valence (charge) or bond with other elements, changing their chemical properties and importantly changing bioavailability and/or toxicity. The exception to this statement is the radionuclides (e.g., uranium), which through radioactive decay can become another element with different chemical properties.

The process of changing chemical properties is observed where mining activities, in part, have exposed waste rock with elevated inorganics to chemical and physical weathering processes thereby increasing their mobility in the environment resulting in them becoming preliminary COCs/COECs. Section 2.10 provides a discussion of the concentrations of the constituents in the unmined source rocks of the Meade Peak Member of the Phosphoria Formation. It is noted there that concentrations of many of the Site contaminants are naturally enriched in the mined rocks, so the accelerated weathering processes due to mining thereby can result in elevated environmental concentrations.

The fate and transport of inorganic elemental chemicals in the environment is a complex process and is influenced by both physical and chemical weathering/transport processes. The transport and attenuation processes include: advection; diffusion; dispersion; adsorption/desorption; solubility; transformation; and even volatilization. These processes are discussed in detail in the *RI/FS Work Plan*. The relative influence or dominance of any of these individual transport mechanisms depends on specific location conditions, the particular chemicals (contaminants), and the interaction of the chemicals within each medium and among the various media that have been investigated at the Site.

Once contaminants are released and become mobile in the environment, attenuation is the primary factor driving changes in inorganic contaminant concentrations that are mobile in any one medium, because degradation and transformation into other compounds are not mechanisms commonly associated with inorganic compounds, except for the radionuclides. For example, uranium-238, the radioisotope that makes up 99% of natural uranium found in the Meade Peak Member of the Phosphoria Formation, decays to radium-226, and to radon-222.

Most commonly, attenuation of inorganic compounds in surface water and groundwater is due to dispersion and dilution (physical processes), and adsorption and precipitation (chemical processes). The physical processes generally affect all of the contaminants similarly. Dilution is mostly relevant to the analyte releases to surface water at the Site, whereas, dispersion is more significant for groundwater transport. However, dilution (e.g., from infiltrating precipitation) can also be a factor in affecting concentrations of preliminary COCs/COECs in groundwater.

The chemical processes that affect individual contaminants are more "analyte specific." At the Site, the chemical processes may be first active within the source areas. For example, a compound released in a near-surface oxidizing portion of a waste rock dump may precipitate near the bottom of a waste rock dump if it encounters a reducing (oxygen deficient) environment within the dump. This may be one explanation as to why the seep and spring discharges from some waste rock dumps have noticeably lower or higher selenium concentrations when compared to others.

The formation of anoxic conditions may be a very relevant process at the Site, because much of the waste rock has been placed as pit backfill or in swales and are covered with lower permeability biologically active (oxygen consuming) vegetated soil. In these conditions, aeration of the waste rock is very limited and initial mobilization of contaminants may be reduced. In addition, the carbon-rich, geochemically-reduced nature of the Phosphoria Formation black shales in the waste rock can dominate and foster the growth of anaerobic bacteria further immobilizing contaminants. These potential attenuation processes are discussed in Section 2.10.2 along with the studies that support them.

The chemical processes also influence the extent and rate of migration of contaminants once they are released into the environment. This is most commonly observed in groundwater, but can also be a factor in soil and surface water. For certain remedies, especially monitored natural attenuation (MNA), a detailed evaluation of these processes may be needed to establish if they are occurring at the Site. For this RI/FS, these studies are deferred to the FS and/or Remedial Design, if needed.

5.3 MIGRATION ASSESSMENTS

The migration of contaminants in the various media at the Site is addressed in this section. The focus is on transport toward off-site areas, as intra-site transport is not a significant issue because of the pervasive nature of the contaminants within the mine area. The exception is where groundwater transport between hydrologic units is of interest. Biotic media, with the exception of vegetation, are not addressed, because site-specific data are sparse and these media are largely evaluated by modeling within the BRA (**Appendix A** and Section 6.0).

Much of the migration discussion for sediment and water transport focuses on selenium. This is because, with a few exceptions, selenium is the most studied and pervasive indicator of Site contamination in media where migration is occurring. In media where transport is occurring, concentrations of other preliminary COCs/COECs are rare. However, if they are present, it can be assumed that other potential contaminants will follow similar migration pathways.

5.3.1 Soil and Vegetation

As presented in Section 5.1.1, the physical migration or movement of contaminants by transport of soil and vegetation downslope is not a significant contaminant migration pathway at the Site. The unchannelized overland transport of soil by surface runoff is generally limited to short distances, if any, away from the waste rock dumps as supported by the upland soil/waste rock data presented in Section 4.1 (transect samples on and off the waste rock dumps and the radiological gamma survey). In both studies results indicate that concentrations of constituents in soil and vegetation rapidly decrease below background levels once off the waste rock dumps. The one exception is radiological survey data that shows elevated gamma measurements along the haul road as it travels through MWD090 and heads to the east. These elevated measurements may be due to several root causes including slag that could have been used on the haul road in the past, residual ore spilled from or blown out of the haul trucks along the road, or mine waste rock that could have been used to construct the road itself.

In addition, the majority of the waste rock generated during mining at the Site was placed back in the pits as backfill and the external waste rock dumps are primarily found between the two ridges discussed in Section 2.1. This configuration has substantially reduced any potential for movement of soil away from the mine area.

The transfer of contaminants between these two relatively static media does not result in significant contaminant movement (cyclic from soil to vegetation then back to soil after plant death). However, once the soil and vegetation erode and become sediment in flowing surface water channels there is a relevant transport and migration pathway. Sediment is discussed in the following Section 5.3.2. In addition, because the contaminants are elevated in the Site soil and vegetation, transport in the form of uptake by biological receptors may occur. The potential uptake by human and ecological receptors is addressed in the BRA (**Appendix A**) and as summarized in Section 6.0.

The primary conclusion for soil and vegetation is:

1. Elevated concentrations of contaminants above background levels in upland soil/waste rock and vegetation are limited to the waste rock dumps with the possible exception of the haul road in the southeast portion of the Site.
2. Soil and vegetation is not a significant migration pathway at the Site, except for potential migration to biota (addressed by the BRA in **Appendix A**).

5.3.2 Sediment and Riparian Soil

The transport of sediment is largely limited to the mine area or proximal downstream areas because of the reclamation and sediment control practices that were utilized at the Site. The flat land surface gradient downstream of the waste rock dumps acts to further limit potential downstream sediment transport because of low flow velocities in the often meandering stream channels. However, it is noted that during the very brief exceptional high flow periods, any sediment that is physically transported in surface water may be deposited on the banks in riparian areas and incorporated into the riparian soil.

Transport of elevated contaminant concentrations in riparian soil and sediment away from the Site appears to be indicated in two areas as noted in Section 4.3. These two areas are: (1) Lone Pine Creek just downstream of the southern portion of the mine; and (2) near or on the Little Blackfoot River where the river crosses through the mine. The elevated concentrations of contaminants in riparian soil and sediment in these areas may: (1) have originated during the active mining operations (erosion prior to closure); (2) be the result of adsorption of dissolved contaminants; (3) be associated with an elevated background; or (4) be the result of ongoing sediment releases, which appears least likely. The tributary to Long Valley Creek on the west side of the Site, which is the third watershed associated with the Site, is not indicated as having been affected by mine sources.

Two branches of Lone Pine Creek near the mine area contain some elevated concentrations of contaminants in riparian soil and sediment. The western-most of these, Strip Mine Creek, is first fed by spring MSG002, and riparian soil at this location does not contain elevated concentrations of contaminants (see Section 4.3 and **Drawing 4-8**). Dump seep MDS022 also feeds Strip Mine Creek, and it contains a few elevated contaminant concentrations (approximately two to three times background) in riparian soil. Just downstream of these locations riparian soil contaminant concentrations are slightly elevated above background levels at MST063 (generally about 2X or less above background levels). Then further downstream at MST062, no concentrations exceed the background levels. Furthermore, stations on Lone Pine Creek below the confluence with Strip Mine Creek also do not exhibit riparian soil with elevated contaminant concentrations. Sediment exhibits a similar pattern. Dump seep MDS022 contains a few slightly elevated concentrations in sediment (e.g., selenium concentration of 1.9 mg/kg compared to background concentration of 1.48 mg/kg). However, no sediment concentrations are elevated above background levels at either MST062 or MST063 (MSG002 sediment has not been sampled). This suggests that Strip Mine Creek, which could receive sediment and impacted water from both MWD086 and MWD090, is affected by elevated contaminants, but only slightly, relatively near the source, and mostly in riparian soil. Up to a mile of Strip Mine Creek could have affected riparian soil with elevated contaminant concentrations down to MST062, but given the slight exceedances near the source area, it is probably a much shorter creek segment that is affected. The lack of sediment with elevated concentrations in the stream suggests that the riparian soil impacts may be associated with a release from the period of active mining. Where elevated concentrations are observed in the seep riparian soil and sediment, it is possible that these result from precipitation or adsorption from the discharging water, which is subjected to chemical changes when entering the surficial environment. This is further discussed in the following section on surface water.

The elevated contaminant concentrations observed east of Strip Mine Creek on Lone Pine Creek are confined to between waste rock dump MWD090, dump seep location MDS016, and stream location MST057. The elevated concentrations occur in both sediment and riparian soil (**Drawing 4-8**). All stations below MST057 on Lone Pine Creek have contaminant concentrations below background levels. Because contaminant concentrations are very near background levels and a small marsh exists at MST057 (i.e., a sediment sink [see photos **Appendix C**]), it is assumed that MST057 is the limit of elevated concentration on this branch of Lone Pine Creek, which is approximately 2,000 feet from the potential source.

In the case of the contaminants in riparian soil in a small tributary to the Little Blackfoot River (MST052), and the nearby river (MST044), the elevated concentrations are coincident with the outcrop/subcrop of Phosphoria Formation, but could also be the result of historic sediment deposition (compare **Drawings 2-2** and **4-7**). Sediment was not sampled at MST052 and did not contain elevated concentrations at MST044. Downstream station MST043 on the Little Blackfoot River had one slightly elevated concentration of selenium (1.7 mg/L compared to a background level of 1.48 mg/L). It appears that any impact from the Site is very localized to riparian soil in the area of Phosphoria Formation outcrop/subcrop with no indication of current sediment impacts. However, with the next downstream station, MST043, more than a mile away, the extent of potential contaminant migration is not well constrained.

The sediment and riparian soil associated with the Site ponds contained elevated concentrations of contaminants (**Drawings 4-7** and **4-8**). In all cases, these ponds are located in mine waste rock areas or, in the case of MSP055, in a mine pit. It is therefore expected that the riparian soil and sediment in these locations would have concentrations of contaminants above background levels. However, in none of these cases is it expected that sediment or riparian soil is migrating away from the ponds. They are likely acting as physical and possibly chemical sinks for contaminants.

Conclusions associated with Site riparian soil and sediment are:

1. As discussed in Section 5.1.2, sediment control features and reclamation practices in place during and after active mining have reduced the potential for impacts to riparian soil and sediment.

2. There is no indication of significant current sediment flux off the Site, and any current impacts to sediment and soil likely would be chemical in nature (e.g., precipitation or sorption from the water column).

3. Elevated riparian soil concentrations are only indicated in stations immediately downstream of Site sources, and sediment is generally less affected, suggesting that impacts may be old and associated with the period of mining.

4. Site ponds have some of the highest contaminant concentrations in riparian soil and sediment; however, this contamination is not migrating. The soil and sediment could act as a source or sink for contaminants in pond water.

5.3.3 Surface Water

The transport of Site contaminants to surface water is primarily due to discharges from contaminant-affected dump seeps and springs. These seeps and springs are located in the headwater areas of drainages in the southern portion of the Site as discussed in Sections 2.3.2 and 4.4. Once discharged to surface water, the transport of any affected water is through common surface water processes (advection, dilution, and attenuation). Surface water runoff during snowmelt or high-intensity rainfall could briefly contribute some contaminant-affected overland surface water flow to the streams originating on the Site. Because the Site has a weathered brown shale/soil cover, the contaminants would be primarily derived from the cover material. However, any such affected water would generally be contained behind sediment retention features as discussed in Section 5.1.3, and concentrations have not been observed to increase during high flow periods at the Site. This is in contrast to other mines such as the Ballard Site and much of the phosphate mining district where elevated concentrations are observed during high flow periods.

The Little Blackfoot River receives flow from one significant tributary, Lone Pine Creek that, in part, has its headwaters on the Site. Lone Pine Creek is discussed in Sections 2.3.1 and 4.4.4. Through attenuation (e.g., dilution, sorption, or redox reactions), elevated concentrations of contaminants do not make it to the Little Blackfoot River via Lone Pine Creek. The most downstream affected station is MST057 (**Drawing 4-10**), similar to riparian soil (Section 5.4.2, above). The next station below MST057 on Lone Pine Creek is MST056, and all COC/COEC results at MST056 are below screening criteria, thereby delineating the downstream extent of elevated COCs/COECs on Lone Pine Creek. Similarly, the tributary to Long Valley creek on the west side of the Site, which rarely contains water, is not identified as a significant pathway.

To assess potential effects on the Little Blackfoot River, either directly from the Site or from the Site associated tributaries, the selenium concentrations in the Little Blackfoot River are considered and plotted on **Figures 4-10 and 4-11**. Rare exceedances of screening criteria have been seen on the Little Blackfoot River, primarily at MST044 (**Drawing 4-9**). Within the Site mine area, samples just upstream of MST044, at dump seep MDS034 and ephemeral stream station MST280 have exceeded screening criteria. However, these locations only flow briefly during the snow melt period.

Conclusions regarding migrating concentrations of preliminary COCs/COECs in flowing Site surface water are:

1. Elevated contaminant concentrations are only observed in flowing surface water immediately downstream of the Site as the result of seep and spring discharges.
2. In Lone Pine Creek, significantly elevated contaminant concentrations do <u>not</u> appear to reach the Little Blackfoot River based on the extensive available data.

3. The tributary to Long Valley Creek on the west side of the Site, which rarely contains any water, does not contain surface water contamination.
4. Elevated concentrations that would indicate an effect from the Site via either direct surface water discharge or groundwater discharge to surface water (e.g., dump seep MDS034) are very rarely observed in the Little Blackfoot River.

Ponds are a class of surface water on the Site that are notably affected by elevated contaminant concentrations. One of these ponds - MSP055 - is a terminal pond in an unbackfilled mine pit (see **Drawing 4-9** for location and contaminant concentrations). This pond is a Tier 3 pond without significant aquatic or riparian habitat as discussed in Section 4.4.2. This pond receives runoff from the surrounding mine pit during snowmelt and high-intensity rainfall. The infiltration rate to groundwater appears to be very low, suggesting that the pond sits on the low-permeability Meade Peak Formation. This is consistent with observations and the typical mining plan of the Henry Mine. The pond appears to receive elevated contaminant concentrations from the mine pit runoff. However, this is further enhanced by the effect of evapoconcentration and possibly contaminant precipitant salts (e.g., Na_2SeO_4) that redissolve during each wetting cycle. Therefore, the concentrations in the pond are not necessarily reflective of runoff concentrations.

Ponds MSP015 and MSP016, are Tier 2 and 1 ponds, respectively, indicating better aquatic and riparian habitat (Section 4.4.2). However, neither pond discharges directly to surface water, and both are apparently affected by interaction with groundwater and/or possible evapoconcentration resulting in some elevated contaminant concentrations (selenium specifically).

Pond MSP014 is a Tier 1 pond with higher quality habitat and elevated selenium concentrations. Given the configuration of the pond and observed concentrations in nearby shallow alluvial monitoring well (MMW010) and seeps/springs, it appears that MSP014 is affected primarily by groundwater interaction. This pond is primarily considered a reflection of the shallow groundwater system, which also appears to discharge at MSG002 and possibly stream station MST063. All these surface water locations exhibit similar selenium concentrations (Section 4.4) generally between 0.01 and 0.1 mg/L.

Conclusions relating to the migration of concentrations of contaminants in Site ponds are:

1. There is no direct discharge to surface water from any of the ponds.

2. Pond MSP055 has multiple elevated contaminant concentrations including arsenic, cadmium, nickel, selenium, and zinc; the other ponds only contain elevated selenium concentrations (Section 4.4.2).

3. MSP055 appears to have minimal groundwater interaction, and therefore, evapoconcentration may be a dominant factor in creating multiple elevated contaminant concentrations in the pond when it contains water.

4. Ponds MSP015 and MSP016 likely reflect groundwater selenium concentrations with some possible effects of evapoconcentration.

5. Pond MSP014 appears to reflect local groundwater selenium concentrations and associated seep/springs concentrations.

5.3.4 Groundwater

The movement of contaminants from the Site into groundwater is evaluated in this section. Section 2.6 provides the physical characterization discussion of the Site groundwater systems, and Section 4.5 presents the nature and extent of groundwater contamination. As discussed in Section 4.5, selenium is the most consistently elevated contaminant in groundwater that exceeds groundwater screening criteria. Cadmium is the only other contaminant that sporadically exceeds its screening criterion of 0.005 mg/L (i.e., in three events at MMW010 by 10 to 25 percent). Arsenic, cobalt, and thallium, are additional contaminants evaluated in Section 4.5 because of risk concerns. However, similar to cadmium, their distribution is sporadic and they rarely exceed background levels.

5.3.4.1 Alluvial System

As discussed in Section 5.1, a large portion of the alluvial system is covered by waste rock in the mine area. Only in two alluvial system areas can migration occur away from the mine into more downgradient portions of the Site. Contaminant migration in these northern and southern alluvial systems is discussed below.

Northern Alluvial System

The alluvial area north of the Little Blackfoot River was difficult to investigate and is not substantial based on the thin alluvial deposits logged during the direct-push investigations, which resulted in several dry holes or refusal due to bedrock. The portion of the alluvial flow system that occurs in the basalt likely is a more significant pathway. The southeast portion of waste rock dump MWD085 is adjacent to the basalt (**Drawing 2-2**). Therefore, seepage or infiltration from MWD085 into the alluvium could flow downhill, infiltrate the basalt and cause impacts to groundwater within the basalt.

Monitoring well MMW004 is located in the basalt between the Little Blackfoot River and the potential waste rock sources. Screening criteria have not been exceeded in this monitoring well (**Drawing 4-11**). It is therefore concluded that alluvial contaminant migration in the alluvial system north of the Little Blackfoot River is not significant.

The Northern Alluvial System south of the Little Blackfoot River is more substantial. Refusal was less common in direct-push borings. While basalt is mapped in the area, alluvial materials occurred at the surface that contain groundwater. There is a clear topographic gradient from the mine area towards the Little Blackfoot River, and alluvial groundwater flow in this complete flow path is directed northerly toward the river and then to a more westerly direction, parallel to the river. Selenium generally has not been detected (<0.006 mg/L) in the alluvial system between the river and MWD088 as presented in Section 4.5.2.1 and **Drawing 4-11**. The only measured selenium concentration near the screening criterion was collected from a direct push borehole near the toe of MWD088 (BH059; 0.041 mg/L Se).

It also is notable that monitoring well MMW019 has not exceeded the screening criteria for any possible contaminant. This monitoring well appears to mostly capture shallow interflow coming from the backfilled pit portion of the MWD088 area, as discussed in Section 2.6.2.2. However, dump seep MDS034 to the east below the reclaimed waste rock dump, discharges seepage with concentrations of selenium up to 0.14 mg/L. However, this dump seep only flows in the spring as the result of spring snowmelt and runoff (Section 2.3.2) and is likely from perched groundwater flowing from MWD088.

Further upstream between ponds MSP015 and MSP016 and along the northeastern edge of the waste rock, a direct push borehole sample was obtained with 0.13 mg/L selenium (BH063). Ponds MSP015 and MSP016 also contain elevated concentrations of selenium up to 0.41 mg/L (**Drawing 4-9**). These ponds appear to be groundwater dominated and possibly enhanced by some evapoconcentration, as discussed in the previous section on surface water.

To summarize, the extent of alluvial impacts in the Northern Alluvial Area are limited to the area south of the Little Blackfoot River. Groundwater selenium concentrations beneath and along the immediate edges of waste rock dump MWD088 exceed screening criterion. No exceedances of other contaminants are seen in any of the locations discussed above. It appears that while elevated selenium concentrations have been located beneath and along the edge of MMWD088, elevated concentrations are not migrating toward the Little Blackfoot River in any significant plumes. This conclusion is supported by the assessment of selenium concentrations in the Little Blackfoot River where it crosses through the Site as presented in Section 4.4.4.2, which showed no systematic increase in selenium concentration between the stations immediately upstream and downstream of the Site contaminant sources.

Southern Alluvial System

The dominant alluvial system in the southern portion of the Site runs along the swale between the mine and the Dinwoody Formation ridge. This thin, narrow alluvial deposit, largely covered by waste rock dump MWD086, joins the Lone Pine Creek alluvium (**Drawing 2-2**). Waste rock dump MWD090 also overlies a portion of this alluvial system in the headwater area of Lone Pine Creek (**Drawing 5-3**).

The flow path from MWD086 and MWD090 to the alluvial groundwater system is an obvious and significant contaminant transport pathway that was extensively investigated (**Drawing 4-12**). The groundwater flow direction is generally easterly then northerly following topography. Similar to what is observed at MWD088 in the northern alluvial area, concentrations beneath waste rock dump MWD086 are elevated.

Monitoring well MMW010 was installed in the shallow alluvium within the footprint of waste dump MWD086. This monitoring well has been sampled since the fall of 2007 and total selenium has ranged from <0.001 to 0.219 mg/L with the higher concentrations observed in the spring and lower concentrations observed in the fall. This suggests that the spring runoff helps contribute preliminary COCs to local groundwater. Similarly, pond MSP014, also present in this area, had an average selenium concentration of 0.0737 mg/L in the spring of 2006, with lower concentrations in the fall. Spring MSG002 and headwater stream location MST063, downstream of MSP014 and MMW010, also appear to be associated with the affected groundwater system and have had elevated selenium concentrations up to 0.0181 mg/L (**Drawing 4-10**). Alluvium further downstream of MMW010 and waste rock dump (MWD086) has either been dry or reported lower selenium concentrations (e.g., BH079 -<0.001 mg/L, BH073 - 0.003 mg/L, BH076 - <0.001 mg/L, BH077 - <0.001 mg/L see **Drawing 4-12** and Section 4.5.2).

There are some indications of an unaffected upwelling groundwater source in the area below MWD086 and MWD090. MSG002 and nearby MDS022 are perennial groundwater discharge sources at the head of the Lone Pine Creek watershed (see Section 2.2.3 for discussion of discharge characteristics). MSG002 is not located beneath a waste rock dump, but likely it is picking up some impacted groundwater because of its close proximity to the base of waste rock dumps MWD086 and MWD090. The spring time water level in MMW014 is within 1 to 2 feet of the ground surface. The observations of perennial discharge and elevated water levels suggest that an upward hydrogeologic gradient in the alluvium may be present in this area. This may explain why the alluvial groundwater immediately downstream of MWD086 are unaffected with no contaminant concentrations exceeding screening criteria. Upwelling unaffected groundwater is directing dump and alluvial groundwater to the surface at MST063 (seasonally) and MSG002. The effect of this discharge on surface water is discussed in the previous section.

The alluvial groundwater downgradient of the northwestern portion of MWD090 is also unaffected by contaminants as shown by MMW014, MDS022, and BH077. However, further to the southeast, downgradient of the southeastern portion of waste rock dump MWD090, the alluvial system is slightly affected, below screening selenium criterion of 0.05 mg/L, by selenium concentrations that range between 0.018 and 0.032 mg/L (see BH158, BH157 and BH167 on **Drawing 4-12**). Seepage from waste dump MWD090 could directly recharge the alluvial system and then flow as shallow groundwater to the northeast into the upper reaches of Lone Pine Creek. In addition, dump seep MDS016, has had selenium concentrations up to 0.018 mg/L (**Drawing 4-10**). Groundwater samples collected further downgradient at BH169 (0.0016 mg/L) are near the groundwater background level. It appears that the alluvial groundwater below the southeastern portion of MWD090 is affected by concentrations of selenium, but below screening criterion of 0.05 mg/L. Regardless of the degree of impact, the plume does not appear to extend more than about 1,000 feet downgradient of the source. Given the relatively low concentrations, the limited extent versus the time the source has been present, it appears likely that if plume expansion is occurring, it is very slow. It is also possible that the plume is static with attenuation balancing any new input.

5.3.4.2 Dinwoody Formation

As discussed in Section 5.1.4.2, the waste rock dumps often are separated from the Dinwoody Formation due to intervening alluvial material. Some transport through thin alluvial deposits to the Dinwoody Formation is possible, but as noted previously, lateral transport is favored in the alluvium. There are other areas where some portion of the waste rock dumps are in direct contact with (overlie) the Dinwoody Formation.

Portions of waste rock dumps MWD085, MWD086, and MWD088 are in direct contact with the Dinwoody Formation without significant intervening alluvial (or colluvial) material. A portion of waste rock dump MWD086 was reclaimed such that the surface was not graded to provide positive drainage allowing rainwater or snowmelt to pool on the dump surface, infiltrate directly into the waste rock dump, and potentially directly impact the Dinwoody Formation. Monitoring well MMW022 was installed in a "worst case" location to evaluate contaminant transport to the Dinwoody Formation pathway (**Drawings 2-2** and **2-3**). Initially selenium concentrations averaged approximately 0.02 mg/L, but after 2011 have increased to approximately 0.045 mg/L (see Section 4.5.2.2 and **Figure 4-17**). This is still below the screening criterion of 0.05 mg/L. However, it suggests exceedances are possible. The increase in concentration at MMW022 coincided with an extremely heavy winter snow season and subsequent runoff/infiltration event as presented in Section 2.6.2, **Figure 2-4** and **Table 2-9**.

Flow in the Dinwoody Formation from MMW022 could be towards the east (Henry Thrust Fault) or to the northwest towards the Little Blackfoot River. The most likely flow path is along strike of the Dinwoody Formation, parallel to the mine waste rock dumps, toward the Little Blackfoot River (the topographically lowest area of Dinwoody Formation at the Site). This pathway was tested by installing MMW028 as illustrated on **Drawing 5-4**. The selenium concentrations in MMW028 have remained at or below 0.01 mg/L, but also showed a slight spike after the 2010/2011 winter (see Section 4.5.2.2 and **Figure 4-18**), which dropped back to normal levels by 2013. This suggests a complete pathway from the Site, but that contaminant migration is attenuated and appears to be not trending upward toward the screening criterion of 0.05 mg/L.

Because of the increased concentration in MMW022, a question remained regarding transport toward and along the Henry Thrust Fault. A spring survey was conducted in the area between MMW022 and the fault, and no springs were found. However, with the moderately low concentrations observed in MMW022 at the time, no further investigation was conducted along what was considered a less likely flow path. Because of the folding associated with the thrust fault and syncline, bedding, in part, is perpendicular to this flow direction. Therefore, transport seems unlikely, and it is presumed that analogous to MMW028, elevated selenium in that potential transport direction also would be low.

As discussed in Section 5.1.4.2, water can infiltrate the backfilled mine pits, which are west of and hydrostratigraphically separated from the Dinwoody Formation by the upper Phosphoria Formation. However, the low conductivity of the Phosphoria Formation reduces the potential of this flow path. Two wells are located in this general flow path, MPW022 and MPW023, and neither has ever had detected concentration of contaminants above screening criteria (**Drawing 4-12**). However, these wells appear to be installed in the upper Phosphoria Formation between the mine pits and the Dinwoody Formation.

5.3.4.3 Wells Formation

Currently, there are two groundwater monitoring wells installed within the Wells Formation at the Site. Monitoring well MMW011 is installed in the break in the ridge where the Little Blackfoot River passes through the Site, and MMW023 is installed in the unbackfilled portion of the South Henry mine pit MMP041 (**Drawings 4-11** and **5-2**). As discussed previously, the conceptual transport model indicates flow to the northwest and toward the springs present near Henry and the Blackfoot Reservoir. As discussed in Section 2.6.2.2, the apparent gradient between the two monitoring wells indicates flow to the northwest helping to confirm this potential. Therefore, monitoring wells MMW011 and MMW023 are appropriately placed for monitoring possible Site impacts to groundwater of the Wells Formation. As presented in Section 4.5.2, monitoring of these wells has indicated relatively low concentrations of selenium from the Wells Formation (less than 0.005 mg/L with one exception; Section 4.5.2, **Figures 4-19** and **4-20**).

The single exception was the spring of 2009 when a concentration of 0.017 mg/L was reported in MMW023 (still well below the selenium screening criterion of 0.05 mg/L). Similar to the winter of 2010/2011, the winter of 2008/2009 was a higher precipitation period (**Table 2-9**). This suggests a very rapid response to a high precipitation period in the unbackfilled portion of MMP041. This observation appears to validate the model in which the upper most beds of the Wells Formation are in hydraulic communication with the mine pits. The high hydraulic conductivity of the Wells Formation at the MMW023 location (2×10^{-2} cm/sec; **Table 2-8**) appears to result in a rapid dissipation of the brief spring influx. Unfortunately, because monitoring was not conducted in the spring of 2011, the response to the 2010/2011 winter snowmelt was not observed. This event had a longer lasting response in other locations where it was observed (e.g., MMW022).

The observation of low concentrations of contaminants in the Wells Formation, in spite of the hydraulic connection, may suggest that selenium in the source areas (backfilled mine pits) is relatively immobile due to reducing conditions in the backfilled waste rock, or that selenium is being attenuated along a flow path that experiences reducing conditions (i.e., in the Wells Formation groundwater). It is highly likely that the response of increased selenium in MMW023 is because of uncovered Meade Peak Member waste rock in the partially backfilled open pit.

As discussed, the Henry Springs discharge at an elevation approximately 6,135 feet AMSL, or approximately 25 feet lower than the water level in MMW023 in the north Henry Mine pit. As such, the Henry Springs are the most probable location of potentially COC-impacted groundwater from the Site (**Drawing 2-2**). The springs and associated flow system were sampled and evaluated by Mayo (1982) and Ralston, et al. (1983). Sampling for the major ions indicate that the water discharging from the springs is a highly evolved calcium-carbonate water type discharging from the Wells Formation. The sulfate content of the springs is low, averaging approximately 50 mg/L. The water discharging from one of the springs was dated at 20,500 years old (Mayo, 1982). The flow volume (> 4,000 gpm), chemistry, and age date indicate this is groundwater discharge from a large portion of the Wells Formation (which represents a large area) and other regional aquifer formations. The springs have not been sampled for COCs; however, given the high flow rate, the highly evolved water quality, and age of the groundwater, it is likely that because of dilution, COCs from the Site would not be detected. Nonetheless, a subset of the springs will be sampled in 2017 for COCs. Refer to **Drawing 2-2** for the area where the Henry Springs are located.

5.3.4.4 Migration Summary in Site Groundwater Systems

Conclusions relating to the migration of contaminants in the Site groundwater systems are:

1. Groundwater selenium concentrations in the alluvial systems above screening criteria (State of Idaho groundwater quality standard/MCL) are seen only beneath and along the edges of the mine waste rock dumps.

2. Alluvial groundwater dominated ponds and some seeps and springs also have elevated selenium concentrations and are a reflection of groundwater that may be present below the mine waste rock dumps.

3. Contaminant transport in alluvial groundwater toward the Little Blackfoot River in the northern alluvial area is not significant and is confined to near the waste rock dumps, and this is corroborated by the lack of a consistent increase in selenium concentrations in the Little Blackfoot River across the mine area.

4. Alluvial groundwater transport of contaminants away from southeastern end of mine waste rock dump MWD090 is indicated, but at concentrations less than the screening criteria and for no more than approximately 1,000 feet downgradient.

5. The conceptual model of contaminant transport into the Dinwoody Formation groundwater on the northeastern edge of the Site appears to be validated, and concentrations in the unit increase with increased winter precipitation and snowmelt. However, to date screening criteria have not been exceeded in the unit with the exception of sulfate, which is not a COC based on its screening criterion (i.e., secondary MCL) not being an ARAR. It is possible that future selenium concentrations could exceed screening levels as the result of sequential or closely spaced above average precipitation years.

6. The hydraulic connection between the mine pits in the Wells Formation groundwater has been confirmed because of the response to increased runoff, but contaminant concentrations in the Wells Formation are well below screening criteria.

7. No groundwater plumes of contaminants exceeding screening criteria are seen at the Site beyond the edge of the mine waste rock dumps.

6.0 BASELINE RISK ASSESSMENT SUMMARY

This section summarizes the results of the BRA performed for the Site, following the approved methodologies outlined in the Human Health and Ecological Risk Assessment Work Plan (HHERA WP) included as Appendix C of the *RI/FS Work Plan*. The approved HHERA WP did not make provisions for a separate livestock evaluation; however, A/T comments on the Ballard Site BRA (dated February 14, 2014) requested that potential hazards to livestock related to grazing on the P4 Sites be presented in a separate livestock risk assessment (LRA). Detailed descriptions of the methods and assumptions used in the HHRA, ERA, and LRA for the Henry Site are presented in **Appendix A**, along with associated risk and hazard calculations.

The potential risks presented in the BRA for the Site are as follows:

1. Receptor-specific human health risk and hazard estimates based on direct exposures to chemicals and radionuclides in primary media: upland soil/waste rock, riparian soil, surface water, groundwater, as well as indirect exposures to chemicals in secondary media, through consumption of: culturally significant plants harvested from upland soil/waste rock, riparian soil, and sediment; home-grown fruits and vegetables grown in upland soil/waste rock and irrigated with groundwater; elk that graze on upland soil/waste rock and consume surface water; cattle that graze on upland soil/waste rock and consume surface water or groundwater; and fish.
2. Receptor-specific ecological hazard estimates based on cumulative exposures to primary and secondary media.
3. Receptor-specific livestock hazard estimates for beef cattle that graze on upland soil/waste rock and consume surface water.

The general approaches used in the HHRA, ERA, and LRA are briefly described in Sections 6.1, 6.2, and 6.3, respectively, and the acceptable risk and hazard criteria are discussed in Section 6.4. Results of the HHRA are summarized in Section 6.5, results of the ERA are summarized in Section 6.6, and results of the LRA are summarized in Section 6.7. Section 6.8 presents the conservative assumptions used in the HHRA, ERA, and LRA and an uncertainty analysis discussion. The HHRA, ERA, and LRA findings and conclusions are presented in Section 6.9.

6.1 HUMAN HEALTH RISK ASSESSMENT

Consistent with the current and potential future land uses described in **Appendix A**, the current and future human receptors evaluated in the HHRA for the Site include:

- Current/Future Native American
- Hypothetical future resident
- Current/Future seasonal rancher
- Current/Future recreational hunter
- Current/Future recreational camper/hiker
- Current/Future recreational fisher

Risks to hypothetical future workers are not evaluated quantitatively; rather, they are semi-quantitatively evaluated by comparison of anticipated exposures for hypothetical future workers to exposures for other receptors that are quantitatively evaluated.

As described in the HHERA WP, all detected constituents in each medium are considered for evaluation in the risk calculations. However, only constituents with concentrations that exceed screening levels are identified as constituents of potential concern (COPCs) and are evaluated further in successive Tier I and II HHRAs. In addition to calculating risk estimates based on Site data, the Tier I and Tier II HHRA methods are used to calculate risk estimates based on the background data for each medium described in the A/T-approved *Background Levels Tech Memo* and *Radiological/Background Report*. For each receptor evaluated, incremental lifetime cancer risks (ILCRs), defined as the incremental increase in cancer risk above the incidence of cancer in the general population, and noncancer hazard quotients (HQs), defined as the ratio of exposure to a noncarcinogenic constituent and the exposure level for that constituent at which no adverse effects are expected, are calculated for individual chemicals. Subsequently, cumulative ILCR and cumulative HQs, or hazard indices (HIs), are calculated for all chemicals over all applicable exposure media.

The Tier I HHRA, also referred to as the "screening HHRA," quantitatively evaluates the cancer risk and noncancer hazard estimates for the (1) Native American, (2) hypothetical future resident, and (3) seasonal rancher scenarios using default reasonable maximum exposure (RME) assumptions and maximum detected concentrations of COPCs in Site and background media. Details of the Tier I HHRA, including the basis of the upper bound RME exposure estimates, are provided in

Appendix A. These three human exposure scenarios cover all relevant abiotic and biotic exposure pathways; therefore, carcinogenic risk and noncarcinogenic hazard estimates for these receptors are assumed to be protective of the other human receptors evaluated in this HHRA (refer to **Figure 6-1**).

The Tier II HHRA, also referred to as the "baseline HHRA," quantitatively evaluates the carcinogenic risk and noncarcinogenic hazard estimates for all six human receptors listed above. The Tier II HHRA evaluates the upper-bound average exposure point concentrations (EPCs) (i.e., the ProUCL recommended upper confidence limit [UCL] on the mean concentration, or the maximum detected concentration for datasets with insufficient sample size for statistical analysis) for Site and background data using both RME and central tendency exposure (CTE) assumptions. As detailed in **Appendix A**, CTE exposure assumptions are based on average, rather than upper bound, estimates of exposure. Use of both RME and CTE assumptions in the Tier II HHRA results in a range of carcinogenic risk and noncarcinogenic hazard estimates to assist risk managers in making informed risk management decisions for the Site. Only RME-based results are presented in Section 6.5, below. The full set of risk results is presented in **Appendix A**.

The Tier II HHRA also includes the calculation of RME-based incremental ILCR and HQ estimates, defined as the COPC-specific difference between the ILCR and HQ estimates for the Site and the ILCR and HQ estimates for background sample locations. COPC-specific incremental ILCR and incremental HQ estimates are summed to cumulative incremental ILCRs and incremental HIs for each medium and receptor. All medium-specific HI estimates exceeding the hazard criterion of 1, as described in Section 6.4, include one or more COPC-specific HQs greater than 1. Therefore, calculation of target organ-specific HI estimates was not necessary to identify risk drivers for any media.

6.2 ECOLOGICAL RISK ASSESSMENT

The ERA evaluates potential exposures and risks to terrestrial and aquatic plant communities, soil invertebrate communities, benthic communities, amphibians and fish, and upper trophic level (i.e., bird and mammal) populations. There are distinct plant communities present at the Site as a result of variations in elevation, moisture, temperature, soil type, slope, and aspect. A 2009 vegetation survey and sampling event at the Site identified the dominant plant species to be comprised of sagebrush/grassland communities, with some aspen/conifer communities and riparian and wetland areas adjacent to ponds, seeps, and streams (see Appendix A2 of the *RI/FS Work Plan*). Site surface water bodies provide drinking water for terrestrial wildlife and support a variety of aquatic and benthic invertebrate species, and likely support larval amphibian life stages. The Little Blackfoot River, which crosses through the northern portion of the Site, supports fish. Information regarding the potential for sensitive species to occur at the Site was obtained from the USFWS. The Canada lynx (*Lynx canadensis*) is the only threatened or endangered species with the potential to occur at the Site. To date, no sightings of Canada lynx have been observed by, or reported to, P4.

An evaluation of all receptors inhabiting a given ecosystem is not plausible and, therefore, representative species were selected as indicator receptors in order to focus the ERA analysis. The indicator receptors quantitatively evaluated in the ERA are: amphibians and fish, long-tailed vole (*Microtus longicaudus*), elk (*Cervus elaphus*), American goldfinch (*Spinus tristis*), deer mouse (*Peromyscus maniculatus*), raccoon (*Procyon lotor*), American robin (*Turdus migratorius*), mallard (*Anas platyrhynchos*), mink (*Mustela vison*), coyote (*Canis latrans*), great blue heron (*Ardea herodias*), and northern harrier (*Circus cyaneus*). The conceptual site model (CSM) for ecological receptors at the Site is shown in **Figure 6-2**. Hazards to special status species (i.e., migratory birds and threatened or endangered species) are evaluated at the organismal scale through use of relevant no-observed-adverse-effect-level-based (NOAEL-based) toxicity reference values (TRVs) associated with physiological functions such as growth and reproduction. Hazards to populations of ecological receptors are evaluated through the use of lowest-observed-adverse-effects-level-based (LOAEL-based) TRVs.

All detected constituents in each medium are considered for evaluation in the risk calculations. However, only constituents with concentrations that exceed ecological screening criteria are identified as constituents of potential ecological concern (COPECs) and are evaluated further in successive Tier I and Tier II ERAs. The ERA considered two ecological effects levels: the TRV_{NOAEL}, the concentration below which no adverse effects to individual receptors is anticipated, and the TRV_{LOAEL}, the concentration below which significant adverse effects to populations are unlikely. In the Tier I ERA, also referred to as the screening ERA, hazard estimates are based on maximum detected concentrations and TRV_{NOAEL} effects levels as detailed in **Appendix A**. In the Tier II, or baseline ERA, hazard estimates are based on the ProUCL-recommended UCL on the mean concentration, or the maximum concentration for datasets of insufficient sample size for statistical analysis, and both TRV_{NOAEL} and TRV_{LOAEL} effects levels to characterize the range of potential adverse effects.

In addition to Site data, the Tier I and Tier II ERA methods are used to evaluate background sample results. Background ecological hazard estimates are compared to Site ecological hazard estimates quantitatively, but incremental hazards are not calculated. The Tier II ERA results in Section 6.6 include TRV_{NOAEL}-based hazard estimates only. Refer to **Appendix A** for all ecological hazard estimates.

6.3 LIVESTOCK RISK ASSESSMENT

The LRA describes the methods used in, and results of, an evaluation of the potential hazards that selenium and other contaminants pose to livestock. Currently, there is no state or federal guidance for conducting predictive risk assessments for livestock. Therefore, ERA procedures used by USEPA under CERCLA (USEPA, 1997) are used to quantitatively evaluate potential risks to livestock.

The primary livestock species grazing on reclaimed mine sites in the Phosphate Resource Area are beef cattle and sheep. Due to the uncertainty in modeling uptake and effects to specific livestock animals, it is assumed that one livestock indicator receptor would be sufficient to quantify potential hazards to all livestock species. Sheep have a dietary preference for forbs that may include selenium hyperaccumulator species, and therefore toxic episodes involving sheep have occurred more frequently during authorized and unauthorized grazing at the reclaimed mine sites than incidents involving cattle. Beef cattle are more sensitive to selenium toxicity than sheep, but cattle have a preference for grasses over forbs.

Beef cattle grazing on State and Federal lands are a beneficial use of these lands. The P4 Sites are particularly attractive for cattle grazing due to the grass mixtures that are used for re-vegetation during post-mining reclamation. Reclaimed portions of the Henry Site are currently used for grazing. Based on current and anticipated future beef cattle grazing uses of the reclaimed P4 Sites, and the fact that horses do not graze on the P4 Sites, beef cattle (*Bos taurus*) were selected as the indicator receptor for livestock in the Ballard and Henry Site LRAs.

The CSM for beef cattle at the Site is depicted in **Figure 6-3**. Complete exposure pathways between beef cattle and contaminated media at the Site include incidental ingestion of upland soil/waste rock and consumption of upland vegetation and surface water.

Similar to the ERA, the LRA is structured in a tiered manner, with the first tier utilizing maximum concentrations and TRV_{NOAEL} toxicity assumptions, and the second tier utilizing upper bound average concentrations and both TRV_{LOAEL} and TRV_{NOAEL} toxicity assumptions. Because livestock screening criteria have not been developed, the list of constituents evaluated as livestock chemicals of potential concern (LCOPCs) is equivalent to the list of COPECs used in the ERA. Due to the paucity of published toxicity information for livestock, the LRA also utilized TRVs for ecological receptors. Only the TRV_{NOAEL}-based hazard estimates are presented in Section 6.7. Refer to **Appendix A** for all livestock hazard estimates.

6.4 ACCEPTABLE RISKS

USEPA currently considers sites with a cumulative human health carcinogenic risk estimate between 1 x 10^{-6} and 1 x 10^{-4}, and a noncarcinogenic HI of less than 1, to be appropriate for conditional closure (USEPA, 1991). IDEQ selected a single value to facilitate risk management decisions, and considers a cumulative carcinogenic risk of 1 x 10^{-5} and noncarcinogenic HI of 1 as the point of departure for making risk management decisions concerning a site (IDEQ, 2004c). Chemicals and pathways for which the carcinogenic risk and/or noncarcinogenic HI estimates exceed these IDEQ and USEPA risk and hazard criteria in the Tier I HHRA are further evaluated in the Tier II HHRA as discussed in Section 6.1. Chemicals and pathways for which acceptable risk criteria are exceeded in the Tier II HHRA will be proposed for: (1) additional data collection to revise the conceptual exposure model and provide more realistic exposure and risk estimates, or (2) evaluation of remedial alternatives in the FS.

Chemical-specific ecological HQ estimates are generally interpreted as follows:

- A NOAEL-based HQ less than 1 indicates that potential adverse effects are not likely.
- A NOAEL-based HQ greater than 1 and a LOAEL-based HQ less than 1 indicates that potential adverse effects may occur to individuals.
- A LOAEL-based HQ greater than 1 indicates that adverse effects may occur to populations of ecological receptors.

Note that acceptable risk levels for livestock have not been established. However, for this risk assessment, the HQ criterion for ecological receptors is applied to the evaluation of beef cattle.

As with the tiered HHRA, chemicals for which the NOAEL-based HQ exceed 1 are further evaluated in the Tier II ERA or Tier II LRA. Chemicals for which the NOAEL-based HQ exceed 1 in the Tier II ERA or LRA will be proposed for further refinement and assessment, or evaluation of remedial alternatives in the FS.

6.5 SUMMARY OF HUMAN HEALTH RISK ESTIMATES

COPCs evaluated in the HHRA are presented in **Table 6-1**. Tier I and Tier II RME human health risk estimates for Site and background data associated with those COPCs are summarized in this section. Tier II CTE risk estimates are presented in **Appendix A**, and detailed risk estimate calculations for are presented in **Attachments B** through **D** of **Appendix A**.

6.5.1 Tier I Risk Estimates

Tier I risk estimates for the three human receptors with the highest potential exposure to environmental media at the Site and background locations are summarized below and in **Table 6-2** through **Table 6-7**. Chemicals with risk and hazard estimates exceeding the acceptable risk criteria described in Section 6.4 are identified as Tier I COPCs for further evaluation in the Tier II HHRA, and are listed by receptor and media in the following subsections.

6.5.1.1 Current/Future Native American

Cumulative Tier I RME ILCR and noncancer HI estimates for a current/future Native American across all exposure media at the Site are 4 x 10^{-3} and 101, respectively (**Table 6-2**). Cumulative Tier I RME ILCR and noncancer HI estimates for a current/future Native American across all exposure media at background sample locations are 3 x 10^{-3} and 163, respectively (**Table 6-3**).

Based on the Tier I HHRA results, upland soil/waste rock, riparian soil, surface water, culturally significant plants grown in upland and riparian soil and aquatic environments, and fish exposed to surface water and sediment are further evaluated in a Tier II HHRA for the current/future Native American. No excess risk or hazard is associated with consumption of elk; therefore, this pathway is not carried forward to the Tier II HHRA for the current/future Native American.

6.5.1.2 Hypothetical Future Resident

Cumulative Tier I RME ILCR and noncancer HI estimates for a hypothetical future resident across all exposure media at the Site are 7 x 10^{-2} and 348, respectively (**Table 6-4**). Cumulative ILCR and noncancer HI estimates for a hypothetical future resident across all exposure media at background sample locations are 6 x 10^{-2} and 157, respectively (**Table 6-5**).

Based on the Tier I HHRA results, upland soil/waste rock, fruits and vegetables irrigated with groundwater and harvested from upland soil/waste rock, groundwater, fish exposed to surface water and sediment, and indoor air are further evaluated in a Tier II HHRA for the hypothetical future resident. No excess risk or hazard is associated with exposure to riparian soil or surface water;

therefore, these pathways are not carried forward to the Tier II HHRA for the hypothetical future resident.

6.5.1.3 Current/Future Seasonal Rancher

Cumulative Tier I RME ILCR and noncancer HI estimates for a current/future seasonal rancher across all exposure media at the Site are 2 x 10^{-3} and 16, respectively (**Table 6-6**). Cumulative Tier I RME ILCR and noncancer HI estimates for a current/future seasonal rancher across all exposure media at background sample locations are 1 x 10^{-3} and 9, respectively (**Table 6-7**).

Based on the Tier I HHRA results, upland soil/waste rock, cattle grazed on upland soil/waste rock with surface water and groundwater as a water source, and groundwater are further evaluated in a Tier II HHRA for the current/future seasonal rancher.

6.5.2 Tier II RME Risk Estimates

Constituents associated with excess risk or hazard in the Tier II HHRA are indicated in **Table 6-8**. Tier II RME risk estimates for human health receptors exposed to environmental media at the Site and background locations are described below and summarized in **Tables 6-9** through **6-14**. As stated in Section 6.4, risk and hazard estimates less than IDEQ and USEPA acceptable cancer risk and noncancer hazard criteria of 1 x 10^{-6} (the lower end of the USEPA's risk management range) and 1, respectively, are considered acceptable. Constituents with Tier II RME risk and hazard estimates exceeding these criteria are identified as risk drivers (preliminary COCs) for further evaluation in this *RI Report*, as discussed in Section 4.0, and are listed by receptor and media in the following subsections. The summaries below provide brief descriptions of the total, background, and incremental risk estimates, with emphasis on the incremental risk estimates, which represent potential risks attributable to the Site. As described in Section 6.1, incremental risk and hazard estimates are calculated as the chemical-specific difference between Site and background risk and hazard estimates, and are summed to a cumulative incremental risk and hazard. Chemical- and medium-specific risk and hazard estimates for each receptor are presented in the referenced tables. Complete details for Tier II RME Site, background, and incremental risks are provided in **Appendix A**.

6.5.2.1 Current/Future Native American

Cumulative Tier II RME ILCR and noncancer HI estimates for a current/future Native American across all exposure media at the Site are 1 x 10^{-3} and 44, respectively (**Table 6-9**). Tier II RME

ILCR and noncancer HI estimates for a current/future Native American across all exposure media at background sample locations are 1 x 10^{-3} and 139, respectively (**Table 6-9**).

Cumulative incremental Tier II RME ILCR and noncancer HI estimates for a current/future Native American across all exposure media at the Site are 6 x 10^{-4} and 26, respectively (**Table 6-9**). The ILCR associated with metals is 2 x 10^{-4}; this cumulative incremental Tier II RME ILCR is associated with arsenic exposures in upland soil/waste rock, surface water, and culturally significant plants harvested from aquatic environments. The cancer risk associated with radionuclides is 4 x 10^{-4}; this cumulative incremental Tier II RME ILCR is associated with radium-226 and decay product exposures in upland soil/waste rock, culturally significant plants harvested from upland soil/waste rock and aquatic environments, and fish. The cumulative incremental Tier II RME HI for the current/future Native American is attributable to the following exposure pathways and preliminary COCs: culturally significant plants harvested from upland soil/waste rock (selenium); culturally significant plants harvested from riparian soil (selenium and vanadium); and culturally significant plants harvested from aquatic environments (cadmium, selenium, uranium, and zinc).

6.5.2.2 Hypothetical Future Resident

Cumulative Tier II RME ILCR and noncancer HI estimates for a hypothetical future resident across all exposure media at the Site are 4 x 10^{-2} and 97, respectively (**Table 6-10**). Cumulative Tier II RME ILCR and noncancer HI estimates for a hypothetical future resident across all exposure media at background sample locations are 2 x 10^{-2} and 126, respectively (**Table 6-10**).

Cumulative incremental Tier II RME ILCR and noncancer HI estimates for a hypothetical future resident across all exposure media at the Site are 2 x 10^{-2} and 69, respectively (**Table 6-10**). The Tier II RME ILCR associated with metals is 1 x 10^{-3}; this cumulative incremental Tier II RME is associated with arsenic exposures in upland soil/waste rock, fruits and vegetables irrigated with groundwater and harvested from upland soil/waste rock, and groundwater. The cancer risk associated with radionuclides is 2 x 10^{-2}; this cumulative incremental Tier II RME ILCR is associated with radium-226 and decay product exposures in upland soil/waste rock and fruits and vegetables harvested from upland soil/waste rock; and radon-222 in indoor air. The cumulative incremental Tier II RME HI for a hypothetical future resident is attributable to the following exposure pathways and preliminary COCs: fruits and vegetables irrigated with groundwater and harvested from upland soil/rock (arsenic, cadmium, molybdenum, selenium, and thallium); and groundwater (cobalt and thallium).

6.5.2.3 Current/Future Seasonal Rancher

Cumulative Tier II RME ILCR and noncancer HI estimates for a current/future seasonal rancher across all exposure media at the Site are 5 x 10^{-4} and 7, respectively (**Table 6-11**). Cumulative Tier II RME ILCR and noncancer HI estimates for a current/future seasonal rancher across all exposure media at background sample locations are 2 x 10^{-4} and 3, respectively (**Table 6-11**).

Cumulative incremental Tier II RME ILCR and noncancer HI estimates for a current/future seasonal rancher across all exposure media at the Site are 3 x 10^{-4} and 4, respectively (**Table 6-11)**. The Tier II RME ILCR associated with metals is 5 x 10^{-5}; this cumulative incremental Tier II RME ILCR is associated with arsenic in upland soil/waste rock, cattle that have grazed on upland soil/waste rock and ingested surface water or groundwater, and groundwater. The cancer risk associated with radionuclides is 3 x 10^{-4}; this cumulative incremental Tier II RME ILCR is associated with radium-226 and decay product exposures in upland soil/waste rock and cattle that have grazed on upland soil/waste rock. The cumulative incremental Tier II RME HI for the current/future seasonal rancher is attributable to cattle that have grazed on upland soil/waste rock and ingested surface water or groundwater (thallium).

6.5.2.4 Current/Future Recreational Hunter

Cumulative Tier II RME ILCR and noncancer HI estimates for a current/future recreational hunter across all exposure media at the Site are 1 x 10^{-4} and 0.04, respectively (**Table 6-12**). Cumulative Tier II RME ILCR and noncancer HI estimates for a current/future recreational hunter across all exposure media at background sampling locations are 4 x 10^{-5} and 0.01, respectively (**Table 6-12**).

Cumulative incremental Tier II RME ILCR and noncancer HI estimates for a current/future recreational hunter across all exposure media at the Site are 6 x 10^{-5} and 0.02, respectively (**Table 6-12**). The Tier II RME ILCR associated with metals is 5 x 10^{-7}, which is below IDEQ's and USEPA's acceptable risk criteria. The cancer risk associated with radionuclides is 6 x 10^{-5}; this cumulative incremental Tier II RME ILCR is associated with radium-226 and decay product exposures in upland soil/waste rock. The Tier II RME HI is below IDEQ's and USEPA's acceptable hazard criteria.

6.5.2.5 Current/Future Recreational Camper/Hiker

Cumulative Tier II RME ILCR and noncancer HI estimates for a current/future recreational camper/hiker across all exposure media at the Site are 6 x 10^{-5} and 0.02, respectively (**Table 6-13**). Cumulative Tier II RME ILCR and noncancer HI estimates for a current/future recreational camper/hiker across all exposure media at background sampling locations are 2 x 10^{-5} and 0.01, respectively (**Table 6-13**).

Cumulative incremental Tier II RME ILCR and noncancer HI estimates for a current/future recreational camper/hiker across all exposure media at the Site are 4 x 10^{-5} and 0.01, respectively (**Table 6-13**). The Tier II RME ILCR associated with metals is 8 x 10^{-7}, which does not exceed IDEQ's and USEPA's acceptable risk criteria. The cancer risk associated with radionuclides is 4 x 10^{-5}; this cumulative incremental Tier II RME ILCR is associated with radium-226 and decay product exposures in upland soil/waste rock. The Tier II RME HI is below IDEQ's and USEPA's acceptable hazard criteria.

6.5.2.6 Current/Future Recreational Fisher

Cumulative Tier II RME ILCR and noncancer HI estimates for a current/future recreational fisher across all exposure media at the Site are 3 x 10^{-5} and 12, respectively (**Table 6-14**). Cumulative Tier II RME ILCR and noncancer HI estimates for a current/future recreational fisher across all exposure media at background sampling locations are 3 x 10^{-5} and 83, respectively (**Table 6-14**).

Cumulative incremental Tier II RME ILCR and noncancer HI estimates for a current/future recreational fisher across all exposure media at the Site are 6 x 10^{-7} and 0.003, respectively (**Table 6-14**). The Tier II RME ILCR is associated with metals only, as the risk associated with radium-226 exposure for the recreational fisher is de minimus in the Tier I HHRA, and therefore not evaluated in the Tier II HHRA. These ILCR and hazard estimates do not exceed IDEQ's and USEPA's acceptable risk and hazard criteria.

6.6 SUMMARY OF ECOLOGICAL HAZARD ESTIMATES

Constituents evaluated in the ERA are presented in **Table 6-15**; potential ecological hazards for receptors exposed to COPECs in environmental media at the Site and background locations are summarized in this section. Detailed ecological hazard estimate calculations are presented in **Attachments F** through **I** of **Appendix A**.

6.6.1 Tier I Ecological Hazard Estimates

Tier I ecological hazard estimates for the Site and background locations are summarized in **Tables 6-16** through **6-18**. With the exception of elk (for which Tier I HQ estimates are less than the ecological hazard criterion of 1) and fish and amphibians (for which only screening level hazard evaluation methods exist), all receptors are further evaluated in the Tier II ERA.

6.6.2 Tier II Ecological Hazard Estimates

NOAEL-based Tier II ecological hazard estimates for the Site and background locations are described below and summarized in **Tables 6-19** and **6-20.** LOAEL-based Tier II ecological hazard estimates are presented in **Appendix A**.

Long-tailed Vole

The NOAEL-based Tier II HQ estimates for a long-tailed vole exposed to contaminated media at the Site range from 0.012 to 38, as shown in **Table 6-19**. Chemicals with Tier II hazard estimates exceeding an HQ of 1 for the long-tailed vole are antimony, chromium, molybdenum, nickel, selenium, and thallium.

The NOAEL-based Tier II HQ estimates for a long-tailed vole exposed to media at background sampling locations range from 0.0071 to 28, as shown in **Table 6-20**. Chemicals with Tier II hazard estimates exceeding an HQ of 1 for the long-tailed vole are antimony, molybdenum, selenium and thallium.

American Goldfinch

The NOAEL-based Tier II HQ estimates for an American goldfinch exposed to contaminated media at the Site range from 0.00035 to 19, as shown in **Table 6-19**. Chemicals with Tier II hazard estimates exceeding an HQ of 1 for the American goldfinch are chromium, copper, molybdenum, nickel, selenium, and vanadium.

The NOAEL-based Tier II HQ estimates for an American goldfinch exposed to media at background sampling locations range from 0.00021 to 7.8, as shown in **Table 6-20**. Chemicals with Tier II hazard estimates exceeding an HQ of 1 for the American goldfinch are chromium, selenium and vanadium.

Deer Mouse

The NOAEL-based Tier II HQ estimates for a deer mouse exposed to contaminated media at the Site range from 0.013 to 36, as shown in **Table 6-19**. Chemicals with Tier II hazard estimates exceeding an HQ of 1 for the deer mouse are antimony, cadmium, chromium, copper, molybdenum, nickel, selenium, and thallium.

The NOAEL-based Tier II HQ estimates for a deer mouse exposed to media at background sampling locations range from 0.0075 to 12, as shown in **Table 6-20**. Chemicals with Tier II hazard estimates exceeding an HQ of 1 for the deer mouse are antimony, cadmium, chromium, molybdenum, nickel, selenium and thallium.

<u>Raccoon</u>

The NOAEL-based Tier II HQ estimates for a raccoon exposed to contaminated media at the Site range from 0.0025 to 1.8, as shown in **Table 6-19**. The only chemical with a Tier II hazard estimates exceeding an HQ of 1 for the raccoon is aluminum.

The NOAEL-based Tier II HQ estimates for a raccoon exposed to media at background sampling locations range from 0.0013 to 1.1, as shown in **Table 6-20**. The only chemical with a Tier II hazard estimate exceeding an HQ of 1 for the raccoon is aluminum.

<u>American Robin</u>

The NOAEL-based Tier II HQ estimates for an American robin exposed to contaminated media at the Site range from 0.00020 to 10, as shown in **Table 6-19**. Chemicals with Tier II hazard estimates exceeding an HQ of 1 for the American robin are cadmium, chromium, copper, nickel, selenium, vanadium, and zinc.

The NOAEL-based Tier II HQ estimates for an American robin exposed to media at background sampling locations range from 0.00012 to 4.5, as shown in **Table 6-20**. Chemicals with Tier II hazard estimates exceeding an HQ of 1 for the American robin are cadmium, chromium, selenium and vanadium.

<u>Mallard</u>

The NOAEL-based Tier II HQ estimates for a mallard exposed to contaminated media at the Site range from 0.042 to 6.1, as shown in **Table 6-19**. Chemicals with Tier II hazard estimates exceeding an HQ of 1 for the mallard are aluminum, selenium, and vanadium.

The NOAEL-based Tier II HQ estimates for a mallard duck exposed to media at background sampling locations range from 0.0053 to 0.78, as shown in **Table 6-20**. These HQ estimates are all less than the ecological hazard criterion of 1.

<u>Mink</u>

The NOAEL-based Tier II HQ estimates for a mink exposed to contaminated media at the Site range from 0.45 to 176, as shown in **Table 6-19**. Chemicals with Tier II hazard estimates exceeding an HQ of 1 for the mink are aluminum, antimony, cadmium, chromium, copper, molybdenum, nickel, selenium, thallium, vanadium, and zinc. It should be noted that the HQ exceedance by copper is due to a fish tissue concentration modeled from surface water at all Site surface water sampling locations. Although a mink might capture and consume prey from streams and springs too small to support game fish, it is unlikely that this ecological receptor could fill a significant portion of its dietary needs at these locations. If the mink is assumed to forage only at locations where fish are present or likely to be present, the hazard associated with copper no longer exceeds 1.

The NOAEL-based Tier II HQ estimates for a mink exposed to media at background sampling locations range from 0.10 to 312, as shown in **Table 6-20**. Chemicals with Tier II hazard estimates exceeding an HQ of 1 for the mink are aluminum, antimony, copper, nickel, selenium and thallium.

Coyote

The NOAEL-based Tier II HQ estimates for a coyote exposed to contaminated media at the Site range from 0.00093 to 3.0, as shown in **Table 6-19**. Chemicals with Tier II hazard estimates exceeding an HQ of 1 for the coyote are molybdenum, selenium, and thallium.

The NOAEL-based Tier II HQ estimates for a coyote exposed to media at background sampling locations range from 0.00056 to 1.4, as shown in **Table 6-20**. The only chemical with a Tier II hazard estimate exceeding an HQ of 1 for the coyote is molybdenum.

Great Blue Heron

The NOAEL-based Tier II HQ estimates for a great blue heron exposed to contaminated media at the Site range from 0.0010 to 11, as shown in **Table 6-19**. Chemicals with Tier II hazard estimates exceeding an HQ of 1 for the great blue heron are selenium and zinc.

The NOAEL-based Tier II HQ estimates for a great blue heron exposed to media at background sampling locations range from 0.00061 to 1.0, as shown in **Table 6-20**. These HQ estimates do not exceed the ecological hazard criterion of 1.

Northern Harrier

The NOAEL-based Tier II HQ estimates for a northern harrier exposed to contaminated media at the Site range from 0.00012 to 1.3, as shown in **Table 6-19**. Chemicals with Tier II hazard estimates exceeding an HQ of 1 for the northern harrier are selenium and vanadium.

The NOAEL-based Tier II HQ estimates for a northern harrier exposed to media at background sampling locations range from 0.000069 to 0.59, as shown in **Table 6-20**. These HQ estimates are all less than the ecological hazard criterion of 1.

6.7 SUMMARY OF LIVESTOCK HAZARD ESTIMATES

Refined LCOPCs evaluated for livestock are presented in **Table 6-21**; potential hazards associated with beef cattle exposure to surficial media at the Site and background locations are summarized in this section. Detailed ecological hazard estimate calculations are presented in **Attachment J** to **Appendix A**. As shown in **Figure 6-3**, beef cattle are evaluated for the following direct and indirect exposure pathways: upland surface soil, surface water, and vegetation.

6.7.1 Tier I Livestock Hazard Estimates

Tier I livestock hazard estimates for the Site and background locations are described below and summarized in **Tables 6-22** and **6-23**. The NOAEL-based Tier I HQ estimates for beef cattle exposed to contaminated media at the Site range from 0.000027 to 8.2, as shown in **Table 6-22**. Chemicals with Tier I hazard estimate exceeding an HQ of 1 for beef cattle are molybdenum, selenium and thallium. The NOAEL-based Tier I HQ estimates for beef cattle exposed to media at background sampling locations are all less than the hazard criterion of 1 (**Table 6-23**).

6.7.2 Tier II Livestock Hazard Estimates

NOAEL-based Tier II livestock hazard estimates for beef cattle exposed to contaminated media at the Site and background locations are all less than the hazard criterion of 1, as shown in **Tables 6-24** and **6-25**. These hazard estimates are consistent with results of the 1999/2000 Henry Mine cattle grazing study, which showed no adverse effects to cattle grazing on reclaimed mine waste rock dumps. LOAEL-based Tier II livestock hazard estimates are presented in **Appendix A.**

6.8 UNCERTAINTY IN RISK ASSESSMENT RESULTS

Both human and ecological risk assessment are based on a series of assumptions and parameters. There is inherent and intentional conservatism in the use of these assumptions and parameters and also uncertainty. To assist interpretation of the risk assessment results presented in this section, the primary sources of conservatism and uncertainty are described in Sections 6.8.1 and 6.8.2, respectively:

6.8.1 Primary Sources of Conservatism

Tier II RME cumulative media ILCR estimates for all six human health receptors calculated based on background concentrations of COPCs range between 2 x 10^{-2} and 2 x 10^{-5}. Background Tier II RME cumulative media HI estimates for the six receptors ranged between 0.009 and 139. Background Tier II NOAEL-based ecological HQs for mammalian receptors ranged from 0.00056 (aluminum for the coyote) to 312 (thallium for the mink). The magnitude of the background risk and hazard estimates for several receptors, exposure pathways and preliminary COCs suggests that there is generally a high degree of conservatism in the BRA for the Site. Primary sources of conservatism in the BRA for the Site are as follows:

- The process used in selecting site COPCs, COPECs, and LCOPCs included comparison of maximum detected concentrations to health-protective screening criteria.
- The EPCs used in the Tier I HHRA, ERA and LRA are based on maximum detected concentrations.
- The EPCs used in the Tier II HHRA, ERA, and LRA are based on the ProUCL recommended UCL on the mean concentrations. When insufficient sample results are available to calculate UCL on the mean concentrations, Tier II EPCs are based on maximum detected concentrations.
- Secondary media exposure pathways, including consumption of culturally significant plants, are evaluated for all constituents identified as COPCs in relevant primary media, even if a given COPC wasn't detected in culturally significant plant samples.
- Modeled COPC concentrations in fruits and vegetables, and culturally significant upland and riparian plants, are based on a mass loading factor (MLF) derived from lettuce that assumes edible portions of plants aren't washed prior to consumption.
- Exposure parameters used in dose modeling are intended to evaluate a worst-case scenario to provide an upper bound on ILCR and HI estimates. For example, the BRA assumes that a seasonal rancher resides at the Site during the period when cattle are grazing; 120 days under the RME exposure scenario, with direct contact exposure to soil and groundwater every day. In reality, seasonal ranchers don't currently reside on the grazing allotments on the Site, nor are they likely to reside there in the future; rather, seasonal ranchers check on and tend to their cattle on an occasional basis. These occasional visits by ranchers might include a day-long horseback ride through the cattle once every few weeks and a return to their off-Site home at the end of each Site visit. During those visits, they would bring their own water (and food) from off-Site because there are no suitable sources of drinking water on the Site.
- Background data for riparian soil, sediment, and vegetation represent only a portion of the potential area disturbed by historic mining, and likely do not adequately represent the entire geologic sequence (i.e., riparian soil, sediment, and vegetation data are not available for areas over or derived from in situ Phosphoria Formation). As a result, it is hypothesized that

background risk estimates for these media are most likely biased low, and corresponding incremental risk estimates for these media are probably biased high.

- Hazard associated with consumption of aquatic prey by ecological receptors is based on data from all surface water sampling locations, rather than only those locations where fish are present or are likely to be present.
- The exposure assumptions, media transfer factors, and toxicity values used in the HHRA, ERA, and LRA are intended to err on the conservative side.

The above sources of conservatism are described in more detail in **Appendix A**.

6.8.2 Primary Sources of Uncertainty

The primary sources of uncertainty in the BRA for the Site are as follows:

- Detection limits for non-detect metals exceeded COPC screening criteria for one analyte (cobalt) in surface water and seven analytes (arsenic, cadmium, chromium, cobalt, manganese, nickel, and vanadium) in groundwater. However, these analytes are either retained as COPCs due to detected concentrations above screening criteria (cobalt in surface water and arsenic, chromium, cobalt, and manganese in groundwater) or detected concentrations and detection limits are below screening criteria in 56 of 58 samples (cadmium in groundwater) or 31 of 33 samples (nickel and vanadium in groundwater).
- Detection limits exceeded ecological screening levels for two analytes (antimony and boron) in upland soil/waste rock, one analyte (antimony) in riparian soil and sediment, and four analytes (beryllium, boron, cobalt, and vanadium) in surface water. With the exception of beryllium, which was never detected, these analytes are retained as COPECs for their respective media due to detected concentrations above screening criteria; therefore, potentially elevated detection limits for these metals had no effect on COPEC selection.
- It's possible that some biota consumption pathways not quantitatively evaluated for a particular receptor could be applicable to that receptor; for example, a hypothetical future resident and a recreational camper/hiker could also hunt, and a hypothetical future resident could also consume aquatic plants.
- Potential uncertainties in the problem formulation phase of the ERA include, but are not limited to, ecological resources determined to be potentially impacted, indicator receptors selected to represent exposed individuals/populations, applicable exposure pathways, exposure information and assumptions, and available contaminant characterization information.
- Area averaging of data over the entire Site potentially underestimates exposures to receptors with small foraging areas; however, a site utilization factor (SUF) of 1 is used in such cases.
- Ingestion rates for culturally significant plants and elk tissue used in the baseline risk assessment for the Henry Site were developed from the US EPA's Exposure Factor Handbook, but do not include the level of community-specificity information summarized in Shoshone-Bannock Tribes (2016). The RME vegetation ingestion rate of 293 grams, or approximately 10 ounces, per day for an adult is approximately double an ingestion rate of about 150 grams per day estimated from Attachment 1 of Shoshone-Bannock Tribes (2016).

Because the Henry Site contains a limited amount of federally managed land where subsistence-level plant and game harvesting can occur, and all consumed vegetation was assumed to be comprised of Henry Site-derived culturally significant plants, the Native American plant consumption risk estimates presented in the Henry Mine RI Report are not believed to be significantly underestimated.

  - Noncancer hazard estimates for ingestion of elk tissue based on an ingestion rate of 44.5 grams per day for an adult and the maximum detected concentration of metals in soil at the Henry Site range from 0.00000033 to 0.040; the cancer risk estimate for consumption of elk tissue is 7.2×10^{-7}. Elk consumption rates estimated from Attachment 2 of Shoshone-Bannock Tribes (2016) range from 169 grams per day to 217 grams per day. Thus, the above supplemental cancer risk and noncancer hazard estimates for elk consumption by a Native American may be underestimated by a factor of about 4 – 5 times. Although the elk ingestion rates for the Native American may underestimate actual elk consumption rates based on the information included in Shoshone-Bannock Tribes (2016), the consumption of elk tissue is a minor contributor to overall risk compared with direct soil contact pathways. Thus while uncertainty in the elk tissue ingestion rate is high, uncertainty associated with the impact of this pathway on the overall conclusions of the baseline risk assessment is low.

- Exposure models for livestock and wildlife do not include uptake factors for selenium hyperaccumulator species (e.g., milk vetch); therefore, ecological hazards associated with selenium in livestock and wildlife could be underestimated if hyperaccumulator species comprise a significant portion of on-Site vegetation at any point in the future. Although this not anticipated because the dominance of beneficial vegetation throughout the reclaimed areas of the Site, and P4's active selenium hyperaccumulator plant species eradication program.
- Uncertainties in the available human health toxicity values evaluated in the HHRA include but are not limited to:
  - Use of the linearized multistage (LMS) model, which assumes that there is no threshold for carcinogenic effects, to extrapolate animal carcinogenicity data to human toxicity criteria.
  - Extrapolation of animal noncarcinogenic toxicity data to humans, and the uncertainty factors (UFs) employed during animal-to-human extrapolations.
  - Lack of published dermal toxicity criteria and the use of oral-to-dermal route extrapolation.
- Uncertainties in the available ecological toxicity values evaluated in the ERA include but are not limited to:
  - Many ecological TRVs are derived from toxicity studies in laboratory animals because wildlife toxicity data aren't available for all metals;
  - Dermal and inhalation TRVs are unavailable for metals; and
  - Fewer published TRVs are available for avians than mammals; as a result, potential hazards to birds could not be evaluated for several COPECs.

Potential uncertainties in the HHRA and ERA for the Site are described in more detail in **Appendix A**.

6.9 BRA SUMMARY

6.9.1 Tier I Human Health Risk Summary

The RME ILCR and noncancer HI estimates for all three receptors evaluated in the Tier I HHRA are in excess of IDEQ's and USEPA's acceptable risk and noncancer HI criteria, as shown on **Table 6-26**. COPCs and pathways associated with excess risk and hazard are further evaluated in the Tier II HHRA. It is worth noting that Tier I RME ILCR and noncancer HI estimates calculated for the above receptors using background concentrations are also in excess of IDEQ's and USEPA's acceptable cancer risk and noncancer hazard criteria (**Table 6-26**). As a result of the Tier 1 HHRA, all human health receptors were evaluated in the Tier II HHRA.

6.9.2 Tier II Human Health Risk Summary

Tier II baseline HHRA risk estimates for all six of the receptors evaluated for exposure to constituents in environmental media at Site and background locations based on upper bound average EPCs and RME assumptions are shown in **Table 6-27**. This table also summarizes incremental risk estimates above background and presents Tier II risk drivers for each receptor and medium. A detailed summary of the Tier II HHRA is presented in Section 7.2.

6.9.3 Tier I Ecological Hazard Summary

Tier I NOAEL-based HQ estimates in excess of 1 are calculated for several receptors and COPECs as shown in **Table 6-16** and **Table 6-28**. Only screening level methods exist for evaluating fish and amphibians, and these receptors are not included in the baseline Tier II ERA. No HQ estimates for the elk exposed to Site surficial media exceeded 1; therefore, elk were excluded from further evaluation in the Tier II ERA.

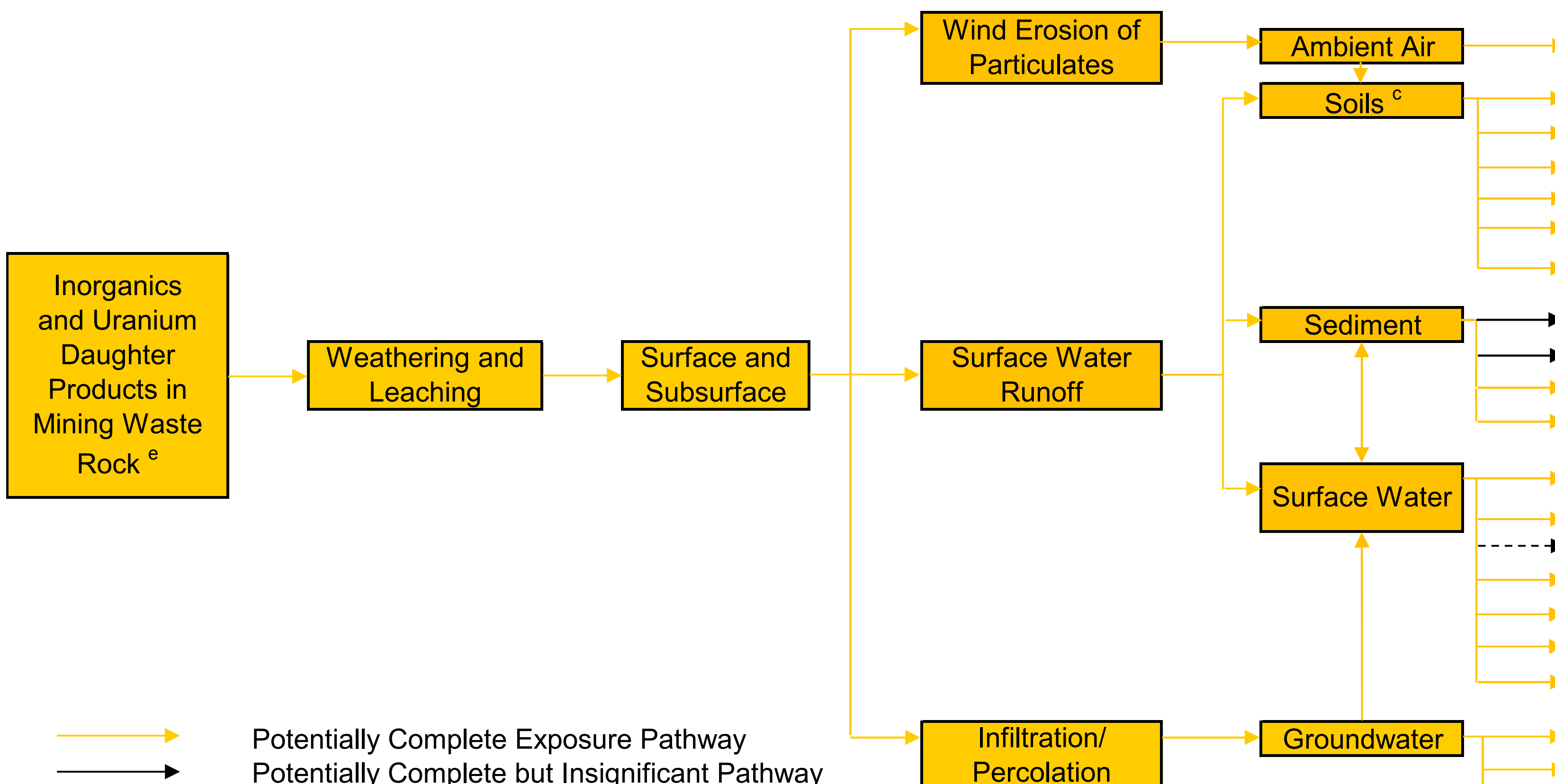
6.9.4 Tier II Ecological Hazard Summary

Tier II NOAEL-based HQ estimates in excess of 1 are calculated for several receptors and preliminary COECs at the Site and background locations, as shown in **Table 6-29**. As shown in **Table 6-19** and **Table 6-20**, ecological hazard estimates for antimony in upland soil (deer mouse and long-tailed vole) and antimony and thallium in riparian soil and sediment (mink) are greater for background locations than for Henry Site locations. Therefore, antimony and thallium are not listed as risk drivers for these media in **Table 6-29**. A detailed summary of Tier II ecological hazard results is provided in Section 7.3.

6.9.5 Tier I and Tier II Livestock Hazard Summary

Tier I NOAEL-based HQ estimates in excess of 1 are calculated for beef cattle exposed to upland soil/waste rock and surface water at the Site for molybdenum, selenium, and thallium. No Tier I NOAEL-based HQ estimates in excess of 1 are calculated for beef cattle exposed to upland soil/waste rock and surface water at background sampling locations. NOAEL-based Tier I risk drivers are evaluated in the Tier II LRA; no Tier II HQ estimates in excess of 1 are calculated using NOAEL-based TRVs. The range of Tier I and Tier II livestock hazards, and Tier I risk drivers, are presented in **Table 6-30** and also summarized in Section 7.4.

FIGURE 6-1
HUMAN HEALTH CONCEPTUAL SITE MODEL
HENRY SITE



Tertiary Sources	Exposure Routes	Native American	Hypothetical Future Resident	Seasonal Rancher	Recreational Hunter	Recreational Camper/Hiker	Recreational Fisher
Ambient Air	Fugitive Dust Inhalation	**●**	**●**	**●**	**●**	**●**	**●**
Soils [c]	Incidental Ingestion	**●**	**●**	**●**	**●**	**●**	**●**
	Dermal Contact	**●**	**●**	**●**	**●**	**●**	**●**
	External Exposure [e]	**●**	**●**	**●**	**●**	**●**	●
	Uptake by Plants	**●**	**●**	○	○	○	○
	Uptake by Moose, Elk, and other Wild Game	**●**	●	○	**●**	●	●
	Uptake by Beef Cattle and Livestock	○	●	**●**	○	○	○
Sediment	Incidental Ingestion	●	●	○	○	●	●
	Dermal Contact	●	●	○	○	●	●
	Uptake by Plants	**●**	○	○	○	○	○
	Uptake by Fish	○	○	○	○	●	●
Surface Water	Incidental Ingestion [f]	**●**	**●**	●	○	●	**●**
	Dermal Contact [f]	**●**	**●**	○	○	●	**●**
	Inhalation	○	○	○	○	○	○
	Uptake by Plants	**●**	○	○	○	○	○
	Uptake by Fish	**●**	**●**	○	○	●	**●**
	Uptake by Moose, Elk, and other Wild Game	**●**	●	○	**●**	●	●
	Uptake by Beef Cattle and Livestock	○	●	**●**	○	○	○
Groundwater	Ingestion	○	**●**	**●**	○	○	○
	Washing/Bathing	○	**●**	**●**	○	○	○
	Irrigation of Plants	○	**●**	○	○	○	○
	Water for Livestock	○	●	**●**	○	○	○

Potential Receptors[a, b]

- Potentially Complete Exposure Pathway
- Potentially Complete but Insignificant Pathway
- Incomplete Pathway
- ● Complete Exposure Pathway
- ● Potentially Complete but Insignificant Pathway
- ○ Incomplete Exposure Pathway

Notes:

[a] All potential receptors are both current and future receptors except for hypothetical future residential receptor.

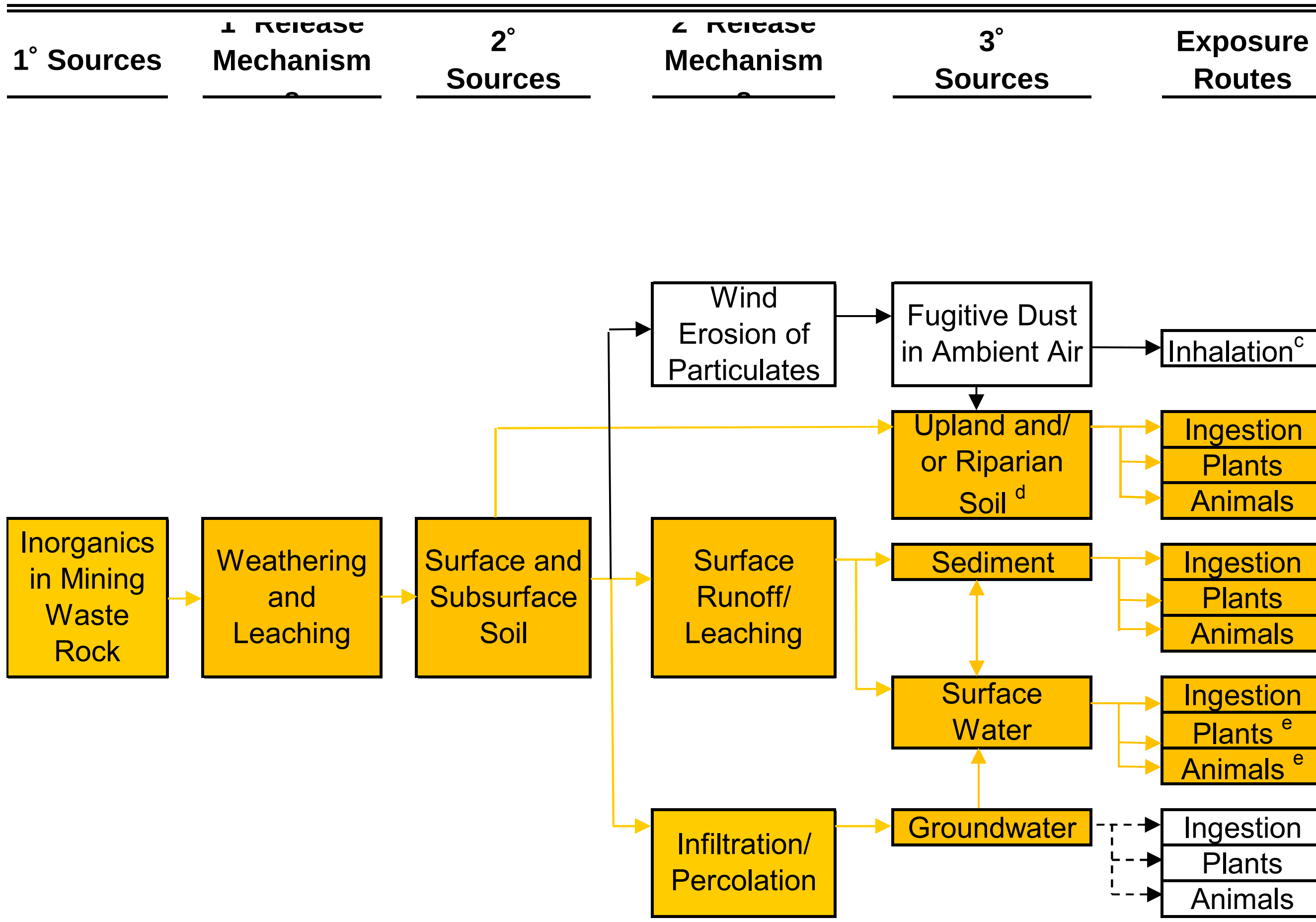
[b] It is possible that some biota consumption pathways could be applicable to multiple receptors. For example, a recreational camper/hiker could hunt. Such alternative exposure pathways are evaluated qualitatively in the Uncertainty Analysis section of the Baseline Risk Assessment.

[c] Exposure to constituents in soil for the current/future recreational hunter, current/future camper/hiker, and current/future seasonal rancher are evaluated quantitatively for upland soil only, as these receptors are not expected to spend a significant amount of time near surface water. The current/future recreational fisher is evaluated for exposure to riparian soil only.

[e] Exposure to uranium daughter products is potentially complete for all potential receptors exposed to Henry Site media via the complete exposure pathways presented. External exposure is only applicable to radiological uranium daughter products and is not applicable to other inorganics. External exposure to radiological uranium daughter products in soil is potentailly complete but insignificant for the recreational fisher because uranium is not a chemical of potential concern in riparian soil.

[f] Direct surface water pathways are incomplete for the current/future recreational hunter, recreational camper/hiker, and seasonal rancher; these receptors are unlikely to spend a significant amount of time near limited surface water, and swimming is an insignificant pathway due to low surface water temperatures.

FIGURE 6-2
ECOLOGICAL CONCEPTUAL SITE MODEL
HENRY SITE



Potential Ecological Receptors

Exposure Route	Invertebrates: Aquatic	Invertebrates: Terrestrial	Fish [b]	Reptiles [a] and Amphibians	Long-tailed Vole, Elk, and American Goldfinch	Deer Mouse and American Robin	Raccoon	Mallard	Mink	Coyote	Great Blue Heron	Northern Harrier
Fugitive Dust – Inhalation[c]	○	○	○	●	●	●	●	●	●	●	●	●
Soil – Ingestion	○	**●**	○	**●**	**●**	**●**	**●**	○	**●**	**●**	●	**●**
Soil – Plants	○	**●**	○	**●**	**●**	**●**	**●**	○	●	**●**	○	○
Soil – Animals	○	○	○	**●**	○	**●**	**●**	○	**●**	**●**	**●**	**●**
Sediment – Ingestion	**●**	○	**●**	**●**	○	○	●	**●**	●	○	**●**	○
Sediment – Plants	**●**	○	**●**	**●**	○	○	**●**	**●**	●	○	○	○
Sediment – Animals	**●**	○	**●**	**●**	○	○	**●**	**●**	**●**	○	**●**	○
Surface Water – Ingestion	**●**	**●**	**●**	**●**	**●**	**●**	**●**	**●**	**●**	**●**	**●**	**●**
Surface Water – Plants [e]	**●**	○	**●**	**●**	○	○	**●**	**●**	○	○	○	○
Surface Water – Animals [e]	**●**	○	**●**	**●**	○	○	**●**	**●**	**●**	○	**●**	○
Groundwater – Ingestion	○	○	○	○	○	○	○	○	○	○	○	○
Groundwater – Plants	○	○	○	○	○	○	○	○	○	○	○	○
Groundwater – Animals	○	○	○	○	○	○	○	○	○	○	○	○

Potentially Complete Exposure Pathway
Potentially Complete but Insignificant Pathway
Incomplete Pathway

●	Complete Exposure Pathway
●	Potentially Complete but Insignificant Pathway
○	Incomplete Exposure Pathway

Notes:

[a] Potential effects to reptiles are evaluated qualitatively.

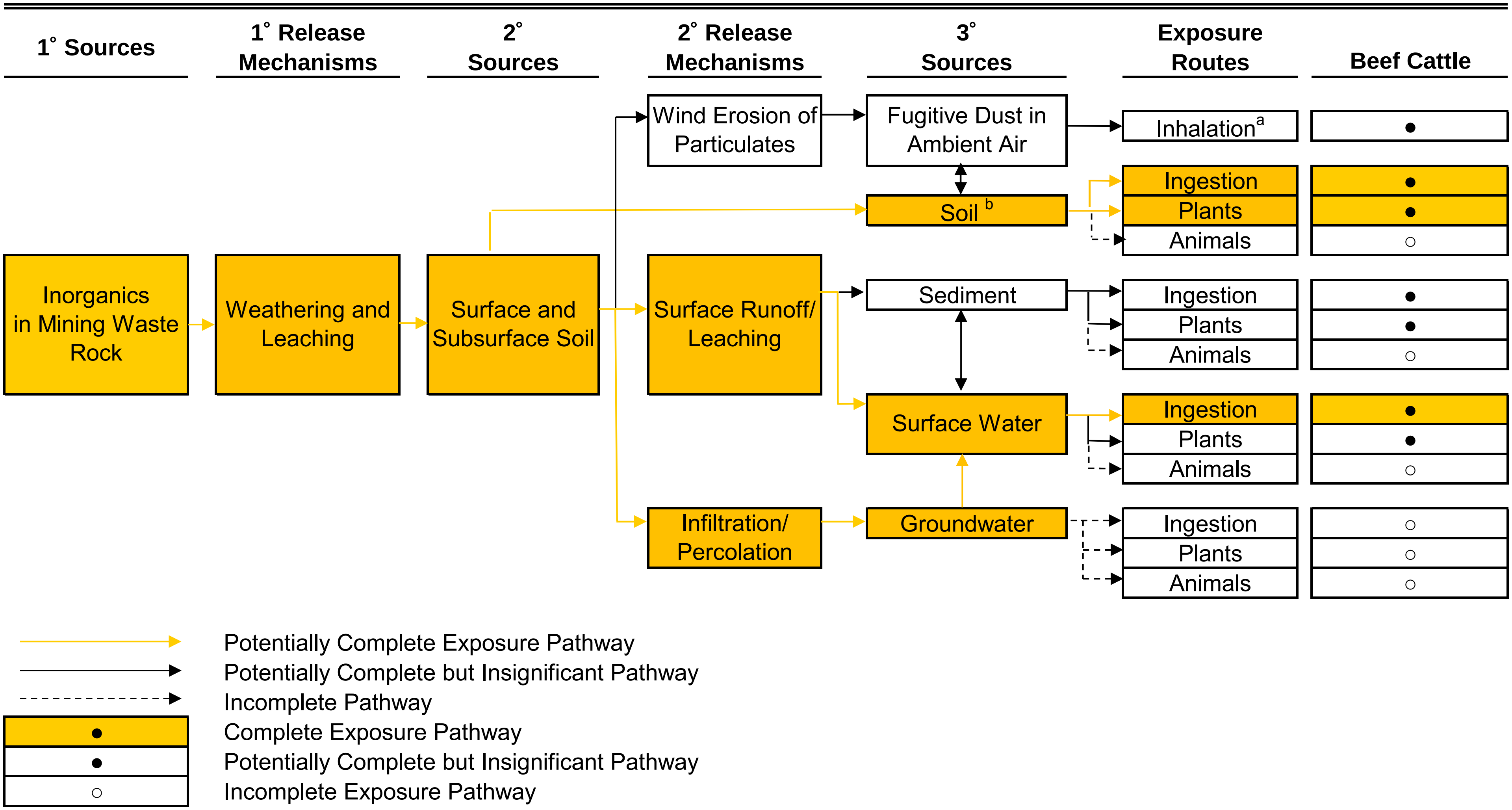
[b] The surface water bodies at the Henry Site support fish, or have the potential to support fish, as described in the Remedial Investigation and Feasibility Study Work Plan (MWH, 2011).

[c] The inhalation pathway is minor relative to the ingestion pathway and there is a lack of relevant toxicological information; therefore this pathway was not evaluated quantitatively for ecological receptors.

[d] For the purpose of the risk assessment, American goldfinch, American robin, coyote, deer mouse, elk, long-tailed vole, and Northern harrier are exposed to upland soil only; and mink, great blue heron and raccoon are exposed to riparian soil only.

[e] Exposure to chemicals of potential ecological concern in surface water through the ingestion of aquatic plants and/or animal pathways were quantitatively evaluated using sediment data when sediment data were available.

FIGURE 6-3
LIVESTOCK CONCEPTUAL SITE MODEL
HENRY SITE



Notes:

[a] The inhalation pathway is a relatively minor exposure route compared with the ingestion pathway, and data and methods for modeling exposure and effects associated with inhalation are insufficient at this time. Therefore this pathway is not evaluated quantitatively for beef cattle.

[b] For the purpose of the livestock risk assessment, beef cattle are assumed to be exposed to upland soil only.

7.0 SUMMARY AND CONCLUSIONS

This section summarizes the nature and extent of contaminant characterization, results and conclusions of the BRA, and recommendations for each primary and secondary medium in support of the FS for the Henry Site.

7.1 INTRODUCTION

The *Guidance for Conducting RI/FS Studies under CERCLA* (USEPA, 1988) states that the RI, after a thorough scoping process and review of available information, is the mechanism for: collecting data to characterize site conditions; determining the nature of the contamination; and assessing risks to human health and the environment. The objective of the RI is to characterize the study area sufficiently enough to (1) determine the need for remedial action and (2) support the identification and evaluation of remedial alternatives in the FS which follows the RI. The characterization presented in this *RI Report* examines the sampling data from numerous media collected from 2004 to 2014 at the Site.

The USEPA (1988) guidance clearly states that the objective of the RI process is not the unattainable goal of removing all uncertainty, but rather to gather information sufficient to support an informed risk management decision regarding the appropriate site remedy. This section summarizes the accomplishments of the RI against these goals and provides recommendations for the next steps in the CERCLA process. Human health, ecological and livestock risks are addressed for each receptor in Sections 7.2, 7.3, and 7.4 and **Appendix A**. Where media have been determined to contain preliminary COCs/COECs that represent a risk to current/future receptors, or exceed regulatory criteria, they are considered COCs/COECs as presented in Section 7.5 and hence will need to be addressed in the FS.

There is a common discussion topic herein with respect to the P4 Sites RI results, specifically the background sites that were sampled to develop background data sets for the various media during the RI. The 2014 re-evaluation of upland soil background levels focused on collection of samples over the entire geologic sequence that was disturbed by Site activities. This is important because the P4 Sites contained outcrops of the Meade Peak and Rex Chert Members of the Phosphoria Formation, which are known to be naturally elevated in some metals, metalloids, and nonmetals (Rex Chert to a lesser extent). As a result of the 2014 investigation, the upland soil background statistics inclusive of the Phosphoria Formation (see *Radiological/Background Report*) are often significantly higher compared to results of the previous background evaluation for upland soil (MWH, 2013). Note that background samples have not been collected from upland or riparian vegetation, riparian soil, or sediment locations overlying or immediately downslope of the Meade Peak Member of the Phosphoria Formation. The lack of representative data from these media in the appropriate background locations almost certainly biases the background levels for some analytes low, especially for constituents such as arsenic and radium-226. This affects the incremental risks calculated for vegetation, riparian soil, and sediment presented below.

7.2 SUMMARY OF CONTAMINATION AND HUMAN HEALTH RISKs

This section summarizes the RI and provides conclusions for each medium under the following subheadings:

- Nature and Extent of Contamination (inclusive of Fate and Transport),
- Risk to Human Health, and
- Information to Support the FS.

A BRA was performed using conservative assumptions to bound risks to current/potential future human receptors. The BRA, which details the methods, assumptions and findings of the bounding human health and environmental assessment, is provided as **Appendix A** and summarized in Section 6.0. The Nature and Extent of Contamination and Information to Support the FS subsections below are inclusive of the human health, ecological, and livestock evaluation. However, the risk-assessment component of this section focuses on the total (Site-related including background) and incremental (Site-related above background) carcinogenic and non-carcinogenic human health risks as discussed below by medium.

Tier I screening-level HHRA risk estimates are calculated for the three receptors (current/future Native American, hypothetical future resident, and current/future seasonal rancher) with the greatest exposure to COPCs in environmental media at Site and background locations using maximum detected concentrations and RME assumptions. Total and background carcinogenic risk and noncarcinogenic hazard estimates calculated for all three of these receptors in the Tier I HHRA are in excess of IDEQ's and USEPA's acceptable criteria, as shown on **Table 6-26** and detailed in **Appendix A**.

Tier II baseline HHRA risk estimates are calculated for all six of the receptors evaluated for exposure to constituents in environmental media at Site and background locations using upper bound average concentrations and both RME and CTE assumptions. Tier II RME and CTE risk estimates are detailed in **Appendix A**. Risks to human health summarized in this Section for each medium are based on the Tier II RME HHRA.

The preliminary COCs, based on results of the HHRA, are presented by medium in **Table 7-1**, and a summary of conclusions is presented in **Table 7-2.** Conclusions for medium are discussed below in the same order as in Section 4.0 and include upland soil/waste rock (Section 7.2.1), upland and riparian vegetation (Sections 7.2.2 and 7.2.3), riparian soil and sediment (Section 7.2.4), surface water (Section 7.2.5), groundwater (Section 7.2.6), and biota (Section 7.2.7).

7.2.1 Upland Soil/Waste Rock

Nature and Extent of Contamination. The RI upland soil/waste rock findings presented in Sections 4.1 and 5.0 of this *RI Report* provide sufficient information to characterize the nature and extent of contamination associated with cover material, waste rock, or other contaminated soil on the Site. The locations and concentrations of constituents in upland soil/waste rock are identified through numerous surface soil samples collected in 2004, 2009, and 2014. The primary source of contamination at the Site is waste rock derived from the center waste shale of the Phosphoria Meade Peak Member that has been placed in various reclaimed waste rock dumps and backfilled mine pits throughout the Site. Concentrations of several preliminary COCs/COECs (arsenic, cadmium, chromium, copper, molybdenum, nickel, radium-226, radon-222, selenium, thallium, vanadium, and zinc) in soil samples collected across reclaimed waste rock dumps, backfilled pits, and the former haul road pose risks and are pervasively elevated above background levels. These analytes mirror the chemical elements known to be elevated in the Meade Peak Member of the Phosphoria Formation. There is a wide range of constituent concentrations in Site soil samples that reflects the heterogeneous nature of the cover materials and waste rock deposited in the dumps and backfilled pits. Sample results from transect sampling collected near the edge of two waste rock dumps and extensive radiological gamma survey investigation indicate no significant off-dump transport is occurring.

Risk to Human Health. Total and incremental carcinogenic risks to Native American, hypothetical future resident, and seasonal rancher receptors are in excess of IDEQ's criterion (1 x 10^{-5}) and USEPA's risk management range (1 x 10^{-6} to 1 x 10^{-4}), while total and incremental carcinogenic risks to the recreational hunter and camper/hiker receptors are above IDEQ's criterion, but do not exceed USEPA's risk management range (**Table 6-27**). Note that background risk estimate for the seasonal rancher also exceeds USEPA's risk management range. In addition, as presented in Section 6.0 and discussed further in Section 7.2.9, worst-case scenario exposure assumptions are utilized in the BRA resulting in conservative risk estimates.

Excess risks for the Native American, hypothetical future resident and seasonal rancher receptors are due to arsenic and radium-226 exposure, and excess risks for the recreational hunter and camper/hiker receptors are due to radium-226 exposure. Total and incremental carcinogenic risks for a hypothetical future resident exposed to modeled concentrations of upland soil/waste rock-derived radium-222 in indoor air exceed IDEQ and USEPA criteria. The acceptable non-cancer HI of 1 is not exceeded for any receptors. As a result, arsenic and radium-226 are identified as preliminary COCs for direct exposure to upland soil/waste rock, and radon-222 is a preliminary COC as a result of indoor air exposure (**Tables 7-1** and **7-2**).

Information to Support the FS. The nature and extent of contamination associated with upland soil/waste rock at the Site and the risks posed to human health and the environment have been sufficiently bounded to evaluate remedial alternatives in the FS. Essentially, the need for upland soil/waste rock risk mitigation is restricted to the Site waste rock dumps and pit areas. The FS process to evaluate remedial technologies and select alternatives will be consistent with USEPA guidance (1988) and the RI/FS SOW.

7.2.2 Upland Vegetation

Nature and Extent of Contamination. The RI upland vegetation findings (Sections 4.2 and 5.0) provide sufficient information to characterize the nature and extent of contamination associated with upland vegetation on the Site. The locations and concentrations of constituents in upland vegetation are identified through numerous plant species samples collected from plants growing in cover soils overlying the reclaimed waste rock dumps and backfilled mine pits in 2004 and 2009. Constituents detected in vegetation samples that have elevated concentrations above background and are associated with excess human health and/or ecological risk estimates are arsenic, cadmium, molybdenum, radium-226 (modeled from uranium), selenium, uranium, and thallium. Similar to upland soil/waste rock, there is a large range in upland vegetation concentrations reflecting the heterogeneous nature of the cover and mine waste rock materials and plant uptake of contaminants in these areas. During the 2009 seasonal investigations, both higher and lower concentrations were reported in forb samples collected in the fall compared to the spring, thus no general conclusions regarding seasonality can be drawn. Vegetation samples collected from culturally significant (CS) vegetation generally show low concentrations of contaminants with the exception of one of the five samples that reported a higher concentration of selenium.

Risk to Human Health. Total and incremental risks to a Native American receptor are in excess of IDEQ's and USEPA's acceptable risk criteria. Specifically, excess total carcinogenic risk is associated with exposure to arsenic and radium-226 (modeled from uranium) in CS plants grown in upland soil/waste rock overlying reclaimed waste rock dumps and backfilled pits (**Table 6-27**). Excess incremental carcinogenic risk is associated with exposure to radium-226 only. The incremental noncancer HI estimate exceeds the acceptable non-cancer HI criterion of 1; this excess hazard is associated with exposure to selenium in upland CS vegetation. The total and incremental carcinogenic risk to a hypothetical future resident consuming fruits and vegetables grown in upland soil/waste rock and irrigated with groundwater also exceed both the IDEQ and USEPA criteria due to arsenic and radium-226 (modeled from uranium). The acceptable incremental non-cancer HI of 1 is exceeded for the hypothetical future resident due to concentrations of arsenic, cadmium, molybdenum, selenium, and thallium in measured non-culturally significant upland plant tissue or fruits and vegetables modeled from upland soil/waste rock and/or groundwater (**Tables 7-1** and **7-2**).

Information to Support the FS. The nature and extent of contamination associated with upland vegetation at the Site and the risks posed to human health and the environment have been sufficiently bounded to evaluate remedial alternatives in the FS. The FS process to evaluate and select remedial alternatives will be consistent with USEPA guidance (1988) and the RI/FS SOW. However, the risks associated with background are very likely significant for vegetation. As such, collection of additional background data may be warranted, as discussed in Section 7.6

7.2.3 Riparian Vegetation

Nature and Extent of Contamination. The RI riparian vegetation findings (Sections 4.2 and 5.0) provide sufficient information to characterize the nature and extent of contamination associated with riparian vegetation on and downstream of the Site. The locations and concentrations of contaminants in riparian vegetation are identified through riparian vegetation samples collected in 2004. Riparian vegetation samples collected in upstream locations, such as ponds and seeps, have concentrations of selenium that are elevated above background. However, contaminant concentrations in riparian vegetation decrease significantly downstream and are only detected above the MDL in one stream station along the Little Blackfoot River (MST044), which is located approximately where the Meade Peak Formation ore horizon crosses beneath the river.

Risk to Human Health. Total and background carcinogenic risks to a Native American receptor consuming CS riparian vegetation are in excess of IDEQ's and USEPA's acceptable risk criteria; this excess risk is due to arsenic in CS vegetation harvested from riparian soil. However, the modeled concentration of arsenic in riparian plants from background locations is only slightly higher (i.e., less than 5%) than the modeled concentration of arsenic in riparian plants from Site locations and, therefore, there is no discernable incremental risk (it is inconsequential) (**Table 6-27**). The acceptable incremental non-cancer HI of 1 is exceeded for a Native American receptor due to selenium and vanadium in CS vegetation harvested from riparian soil (**Tables 7-1** and **7-2**).

Total, background, and incremental carcinogenic risks associated with arsenic and radium-226 (modeled from uranium) in CS aquatic plants derived from Site sediment and surface water are in excess of the acceptable IDEQ and USEPA criteria (**Table 6-27**). Three other preliminary COCs (cadmium, selenium, and zinc) are associated with an exceedance of the acceptable incremental non-cancer HI of 1 under the aquatic plant consumption scenario for the Native American receptor (**Tables 7-1** and **7-2**). Note that the incremental risks may be overestimated based in the current sediment background data set.

Information to Support the FS. The nature and extent of contamination associated with riparian vegetation at the Site and the risks posed to human health and the environment have been sufficiently bounded to evaluate remedial alternatives in the FS. The area of potentially impacted riparian vegetation appears to be limited to small areas surrounding Site ponds. The FS process to evaluate and select remedial alternatives will be consistent with USEPA guidance (1988) and the RI/FS SOW.

7.2.4 Riparian Soil and Sediment

Nature and Extent of Contamination. The RI riparian soil and sediment findings (Section 4.3 and 5.0) provide sufficient information to characterize the nature and extent of contamination associated with downstream transport of Site contaminants in riparian soil and sediment. The locations and concentrations of constituents in riparian soil and sediment were identified through sampling events conducted in 2004 and 2010. As discussed in Section 4.3, evaluation of nature and extent for these two media are combined in this RI, because riparian soil and sediment at the Site are adjacent and contiguous in narrow zones, and proposed future remedial alternatives for these media in the future Site FS likely will be similar. Concentrations of several constituents in riparian soil samples collected from upstream locations (ponds, seeps and some springs) and some downstream locations (streams) are elevated above background levels and are associated with excess human health and/or ecological risks. These preliminary COCs/COECs for both riparian soil and sediment include arsenic, cadmium, chromium, copper, molybdenum, nickel, radium-226 (modeled from uranium), selenium, uranium, vanadium, and zinc and are similar to constituents detected at elevated concentrations in upland soil/waste rock. Concentrations of these contaminants are highest in pond samples and also are elevated in dump seep and springs samples. Some stream stations adjacent to the waste rock dumps also report elevated concentrations. However, concentrations decrease significantly downstream and are below background levels in riparian soil and sediment samples collected from the furthest downstream locations.

Risk to Human Health Associated with Riparian Soil. Total carcinogenic risk estimate for a Native American receptor is below the IDEQ's acceptable risk criterion and within the USEPA's acceptable risk management range, and is driven by direct arsenic exposure. The exposure concentration of arsenic for background sample locations is greater than the exposure concentration of arsenic for Site sample locations and, therefore, there is no incremental risk (**Table 6-27**). The acceptable incremental non-cancer HI of 1 is not exceeded for the Native American receptor. Risks to hypothetical future resident and recreational fisher receptors calculated in the screening-level HHRA are inconsequential and, therefore, riparian soil exposure was not evaluated for these receptors in the baseline HHRA. No analytes are identified as a preliminary COC for direct exposure to riparian soil (**Tables 7-1** and **7-2**).

Risk to Human Health Associated with Sediment. As discussed above in Section 7.2.4, the uptake of sediment constituents by CS aquatic plants, and subsequent consumption by a Native American receptor, is the only complete exposure pathway associated with Site sediment. As a result, there are no significant risks associated with direct exposure to sediment.

Information to Support the FS. The nature and extent of contamination associated with riparian soil and sediment at the Site and the risks posed to human health and the environment have been sufficiently bounded to evaluate remedial alternatives. Areas that need to be addressed are restricted to narrow zones of soil and sediment in the headwater streams near the waste rock dumps. The FS process to evaluate remedial technologies and select alternatives will be consistent with USEPA guidance (1988) and the RI/FS SOW. However, the risks calculated from background concentrations detected in riparian soil, sediment, and associated vegetation are important for the correct calculation of incremental risks to human receptors from these media. It is likely that the incremental risks discussed above for these media are biased high because of the low background concentrations. As such, collection of additional background data may be warranted for these media, as discussed in Section 7.6.

7.2.5 Surface Water

Nature and Extent of Contamination. The RI surface water findings (Section 4.4 and 5.0) provide sufficient information to characterize the nature and extent of contamination associated with surface water at the Site. The locations and concentrations of constituents in surface water are identified through numerous samples collected during spring and fall sample events between 2004 and 2014.

Arsenic, cadmium, and selenium are identified as preliminary COCs/COECs based on the exceedance of screening criteria. Arsenic and cadmium exceedances occur sporadically, and the highest concentrations above screening criteria primarily occur in one location (MSP055). Even if this location is excluded, these elements still may present an unacceptable risk. Other contaminants including nickel, thallium, and zinc, are only a concern in isolated areas (MSP055 and MST275 [thallium only]).

Surface water samples collected from dump seeps, springs, and ponds located near the waste rock dumps contain a greater number of elevated contaminants (i.e., above their respective screening criteria) when compared to stream samples which are generally collected downstream from the sources. Many of the Site streams are fed either by perennial springs or runoff-derived streams (ephemeral) that are dry at the height of summer when spring runoff ends as shown in Site sample station photographs (see **Appendix C**). Perennial tributaries have been sampled in both the spring and fall, and concentrations of selenium during spring concentrations are lower on average in the Little Blackfoot River (**Figures 4-10** and **4-11**). Such a condition would be typical of an unimpacted stream in the area.

Contaminant concentrations indicate that there are no effects to the Little Blackfoot River from the Site due to either direct surface water or groundwater discharge to surface water. Small tributaries that originate in the Lone Pine Creek drainage area exceed screening criteria at stations near the mine; however, elevated concentrations of contaminants do not appear to reach the Little Blackfoot River. The Long Valley Creek tributary on the west side of the Site rarely contains water and does not appear to be a source of contaminants. Several of the ponds have elevated concentrations of several contaminants. However, there is no direct discharge to surface water from the four Site ponds.

Risk to Human Health. Total and incremental risks to a Native American receptor associated with direct exposure to arsenic in surface water are below IDEQ's acceptable risk criterion and fall within the lower end of USEPA's risk management range, as shown on **Table 6-27**. The acceptable incremental non-cancer HI of 1 is not exceeded for a Native American receptor. Arsenic is the only risk-derived constituent identified as a preliminary COC (**Tables 7-1** and **7-2**). Risks to hypothetical future resident and recreational fisher receptors calculated in the screening-level HHRA are inconsequential and, therefore, surface water exposure was not evaluated for these receptors in the baseline HHRA.

Information to Support the FS. The nature and extent of contamination associated with surface water at the Site, and the risks posed to human health and the environment have been sufficiently bounded to evaluate remedial alternatives in the FS. Areas that need to be addressed are restricted to headwater locations in the Lone Pine Creek drainage closer to the waste rock dumps. The FS process to evaluate remedial technologies and select alternatives will be consistent with USEPA guidance (1988) and the RI/FS SOW.

7.2.6 Groundwater

Nature and Extent of Contamination. The RI groundwater findings (Section 4.5 and 5.0) provide sufficient information to characterize the nature and extent of contamination associated with the various hydrostratigraphic units (local, intermediate, and regional) beneath and downgradient of the Site. The locations and concentrations of constituents in groundwater are identified through numerous groundwater samples collected during spring and fall events between 2004 and 2014. As discussed in Section 4.5, selenium is the most consistently elevated constituent that exceeds groundwater screening criteria. The only other constituent that exceeds its screening criteria is cadmium (**Table 7-2**) and exceedances are only reported beneath and along the edge of the waste rock dumps. These two analytes are considered preliminary COCs for groundwater. Arsenic, cobalt, and thallium are identified as preliminary COCs in the BRA as discussed below, but these three risk-derived contaminants do not exceed screening criteria and only sporadically exceed background levels.

The local, intermediate and regional aquifers associated with the Site have the following noted impacts from the sources of contamination (i.e., the waste rock dumps):

- Alluvial groundwater transport toward the Little Blackfoot River in the northern alluvial area is not significant and is confined to near the waste rock dumps. This is also supported by the lack of consistent increases in the Little Blackfoot River across the mine area.
- Alluvial groundwater beneath and along the waste rock dumps in the southern alluvial area are affected by preliminary COC concentrations above screening criteria, and plumes of limited extent extend beyond the dumps. However, concentrations in the plumes do not exceed screening criteria. The extent of groundwater impacts in this area is approximately the same as surface water.
- Groundwater collected from monitoring wells screened near the top of the Dinwoody Formation on the northeast side of the mine appear to be impacted and have increasing preliminary COC concentrations resulting from normal to above average winter precipitation and snowmelt. However, to date groundwater screening criteria have not been exceeded in the unit, and significant downgradient transport toward the Little Blackfoot River is not seen.
- The hydraulic connection between mine pits and the Wells Formation is supported by responses to increased runoff, but preliminary COC concentrations in the formation are well below screening criteria.

Risk to Human Health. Total and incremental risks associated with arsenic exposure to a hypothetical future resident are above the IDEQ criterion, but fall within the USEPA's acceptable risk management range as shown on **Table 6-27**. These risks are at or below IDEQ's criterion and within the USEPA's acceptable risk management range for a seasonal rancher. The contaminants that contribute to the exceedance of the acceptable incremental non-cancer HI of 1 are cobalt and thallium for a hypothetical future resident. Therefore, arsenic, cobalt and thallium are the only identified risk-derived preliminary COCs as shown in **Tables 7-1** and **7-2**.

Information to Support the FS. The nature and extent of contamination associated with groundwater at the Site and the risks posed to human health and the environment have been sufficiently bounded to evaluate remedial alternatives in the FS. Alluvial groundwater near the waste rock dumps in the southwest portion of the Site are impacted similar to surface water. The FS process to evaluate remedial technologies and select alternatives will be consistent with USEPA guidance (1988) and the RI/FS SOW.

7.2.7 Biota

Nature and Extent of Contamination. The RI findings (Section 4.6) regarding aquatic and terrestrial biota provide sufficient information to characterize the nature and extent of contamination associated with biota. A variety of aquatic and terrestrial biological-chemical data were collected during the pre- and post-2004 investigation periods at the Site. The terrestrial data including the Henry Site cattle study have not been validated to current standards, but can be validated as needed to support the RI/FS. Aquatic surveys were conducted in 2004, and forage fish were found at three Site stations and presumed to be located at four other Site stations; all the stations are located on the Little Blackfoot River. Constituent concentrations in the three stations are generally similar with isolated exceedances of background concentrations. Macroinvertebrate samples collected at the Site have relatively few detections and high laboratory report limits due to low sample volumes.

Risk to Human Health. Total and background risks to a Native American, hypothetical future resident, and recreational fisher receptors are in excess of IDEQ's cancer risk criterion, but within USEPA's cancer risk management range (**Table 6-27**). However, total and background risks for these receptors are equivalent, resulting in no incremental risk. Total and background hazard estimates exceed the noncancer criterion; however, the concentrations of risk drivers in fish tissue modeled from background surface water exceed the concentrations modeled from Site surface water and, therefore, there are no incremental risk drivers.

For cattle, total and incremental risks to a seasonal rancher receptor are at or in excess of IDEQ's cancer risk criterion, but fall within USEPA's cancer risk management range (**Table 6-27**). Specifically, excess risks are due to exposure to arsenic and radium-226 in cattle that have grazed on upland pastures and consumed surface water or groundwater. The only contaminant that contributes to an incremental non-cancer hazard in excess of 1 for cattle that have grazed on upland soil/waste rock and consumed surface water or groundwater is thallium (**Tables 7-1** and **7-2**).

Information to Support the FS. The nature and extent of contamination associated with biota at the Site and the potential hazards posed to human health and the environment have been sufficiently bounded to evaluate remedial alternatives in the FS. The FS process to evaluate remedial technologies and select alternatives will be consistent with USEPA guidance (1988) and the RI/FS SOW.

7.2.8 Cumulative Risks from the Combined Media - Implications of Human Health Risk Estimates on Current/Future Land Uses

Currently, reclaimed portions of the Site are used for grazing. This includes former P4-leased BLM and State lands along with privately-held P4 lands. Recreational activities such as hunting currently may occur on former P4-leased State and BLM lands, but is only possible by accessing these areas on foot as P4 maintains fences and locked gates around the mine property. Recreational activities are not permitted on P4-owned portions of the Site.

It should be noted that future Site uses will continue to emphasize grazing on reclaimed State/BLM lands, along with some recreational activities (such as hunting, camping and hiking). Grazing also is the most likely future land use for the reclaimed P4-owned areas of the Site. It is unlikely that recreational use by the public would be permitted by P4 in the future on their privately-held portions of the Site nor would subsistence or residential land uses.

Native American and Hypothetical Future Resident Risks. These receptors were evaluated to determine if land use controls and/or remediation are required to protect humans involved in potential future subsistence or residential land uses for the reclaimed and un-reclaimed mine areas of the Site. Although these land uses are unlikely to occur in the future on the actual mine surface area.

Incremental cancer risk and noncancer HI estimates for the Native American and hypothetical future resident receptors are greater than $1x10^{-4}$ and 1, respectively when considering inputs from all the Site media. Therefore, further evaluations in the FS of area-specific remedial alternatives, including institutional land use controls, will be required to protect potential human receptors under these land uses on the mine area, proper. Because the contaminant concentrations associated with excess risk for these receptors decrease rapidly downslope from the mine dumps, it is anticipated that current or potential future subsistence or residential land uses off the current reclaimed mine dumps would not be adversely impacted.

Seasonal Rancher Risks. The incremental combined-media cancer risk and noncancer HI estimates for the seasonal rancher exceed IDEQ cancer risk and noncancer HI criteria, and the USEPA's cancer risk management range and HI of 1. However, the background cancer risk estimates for this receptor also exceed IDEQ risk criteria and the USEPA's risk management range. It should be noted that the seasonal rancher scenario assumes that seasonal ranchers live on reclaimed Site areas during the portion of the year that their cattle graze on-Site. This assumption assumes daily direct contact exposure to soil and consumption of groundwater as a potable supply during the grazing period. In actual practice, however, seasonal ranchers don't reside on the Site, nor are they likely to reside there in the future; rather, they visit the Site occasionally during the grazing season to check up on, and tend to their cattle. Additionally, it is highly unlikely that a seasonal rancher would install a potable supply well on former P4-leased BLM and State lands or privately-held P4 lands. Currently, and likely in the future, the rancher brings drinking water from off-Site during the occasional Site visits.

If daily direct contact soil exposure pathways and consumption of groundwater are not considered, the incremental cancer risk for the seasonal rancher from beef consumption, is only slightly higher than the IDEQ cancer risk criterion and is within the USEPA risk management range. Although the incremental HI estimate of 4 for the seasonal rancher due to beef consumption remains above 1, the HI is almost solely attributable to thallium in upland soil at an EPC of 1.31 mg/kg. Based on the above, it is highly unlikely that current and anticipated future grazing on reclaimed portions of the Site is adversely affecting the health of seasonal ranchers.

Recreational Hunter, Camper/Hiker, and Fisher Risks. Total and incremental combined-media cancer risk estimates for the recreational hunter and camper/hiker exceed the IDEQ cancer risk criterion but are within the USEPA's risk management range. These upper bound cancer risk and HI estimates are based on conservative assumptions, and, given that incremental combined media cancer risk estimates for these receptors are within the USEPA's risk management range and incremental combined media HIs are below 1, these receptors are not likely to be adversely affected by the Site. Recreational fishing also was evaluated along the Little Blackfoot River only, due to the size, ephemeral nature, and lack of fish at the other surface water features on or downgradient of the Site. Incremental combined media cancer risk and noncancer HI estimates for the recreational fisher are below IDEQ and USEPA cancer risk and noncancer HI criteria. Consequently, this receptor land use has not been adversely impacted by the Site.

7.3 SUMMARY OF ECOLOGICAL RISKS

This section summarizes the findings of the ERA that was performed using conservative assumptions to bound risks to ecological indicator receptors that are possibly found at the Site. The BRA, which details the methods, assumptions and findings of the bounding ERA, is provided as **Appendix A** and summarized in Section 6.0. The preliminary COECs based on the results of the ERA are presented by medium in **Table 7-3** (provided at the end of the section).

Tier I chemical-specific HQs for possible amphibians exposed to surface water COPECs at the Site range from <1 to 313, as presented in **Table 6-16**. Surface water preliminary COECs with HQs higher than IDEQ's and USEPA's acceptable surface water hazard criterion of 1 include aluminum, barium, boron, cadmium, manganese, nickel, selenium, uranium, vanadium, and zinc.

NOAEL-based and LOAEL-based ecological hazard estimates are calculated for terrestrial and riparian upper trophic level ecological receptors exposed to combined media at the Site, as described in detail in **Appendix A**. Tier II NOAEL results are presented in **Table 6-28** and summarized below and in **Table 7-4**. The Tier I and Tier II LOAEL-based hazard estimates are presented in **Appendix A**.

Tier II Risks to the Environment. NOAEL-based Tier II HQ estimates in excess of 1 are calculated for the following receptors: long-tailed vole, deer mouse, raccoon, mink, coyote, American goldfinch, American robin, mallard duck, great blue heron and northern harrier exposed to Site media. NOAEL-based Tier I HQ estimates for the elk are below 1 so elk were not further evaluated in the Tier II assessment. Analytes with NOAEL-based Tier II HQ estimates in excess of 1 include: aluminum, antimony, cadmium, chromium, copper, molybdenum, nickel, selenium, thallium, vanadium and zinc. With the exception of antimony and thallium, for which Site ecological hazards are less than background ecological hazards, these analytes are listed as preliminary COECs in **Table 7-3**.

These ecological risk estimates represent upper bound estimates that may "overestimate" Site risks. As shown in **Table 7-4**, the background HQs are in excess of 1 for all the mammalian receptors that were evaluated and for two of the five avian receptors that were evaluated (exceptions include the mallard duck, great blue heron, and northern harrier).

Information to Support the FS. The nature and extent of contamination associated with biota at the Site and the potential hazards posed to environment, via ecological receptors, have been bounded sufficiently to allow evaluation of remedial alternatives in the FS. The FS process to evaluate remedial technologies and select alternatives will be consistent with USEPA guidance (1988) and the RI/FS SOW.

7.4 SUMMARY OF LIVESTOCK RISKS

This section summarizes the findings of the LRA that was performed using conservative assumptions to bound risks to a livestock indicator receptor. The BRA, which details the methods, assumptions, and findings of the bounding LRA, is provided as **Appendix A** and summarized in Section 6.0. The preliminary LCOCs (based on the results of the LRA) for the Tier I and Tier II LRA are presented in **Table 6-30** and the Tier II results are summarized in **Table 7-4**.

Risk to Livestock. NOAEL-based Tier II HQ estimates for beef cattle exposed to soil, upland vegetation, and surface water at the Site and background locations are below 1 for all LCOCs and, therefore, no adverse effects to livestock are anticipated. It should be noted that sheep deaths have occurred at the Site on one occasion, but that was in association with sheep entering an unauthorized area (i.e., an unreclaimed pit at the Site) which had selenium hyperaccumulator plant species growing in the marginal soils developed on the pit bottom.

Information to Support the FS. The nature and extent of contamination at the Site and the potential hazards posed to livestock have been sufficiently bounded to evaluate remedial alternatives in the FS. The FS process to evaluate remedial technologies and select alternatives will be consistent with USEPA guidance (1988) and the RI/FS SOW.

7.5 SUMMARY OF FINAL COCs/COECs

Table 7-5 presents the list of COC/COECs in each Site medium. These COCs/COECs are developed based on the following criteria:

- Analytes identified as risk drivers in the BRA – preliminary COCs/COECs (Section 6.0 and **Tables 7-1** to **7-4**)
- Analytes that exceeded regulatory benchmarks (screening criteria) – surface water and groundwater (Sections 4.4 and 4.5)
- Analytes that exceed background levels at the Site – soil, sediment, and vegetation.
- Evaluation of spatial and temporal concentration trends (e.g., are elevated concentrations sporadic, anomalous, or occur at a location that is otherwise unaffected while impacted Site location have lower concentrations).

The COCs/COECs identified in **Table 7-5** will be used in the FS evaluation of each medium to determine the most viable technologies for remediation. The analytes by medium that are either eliminated from or added to the list of preliminary COCs/COECs identified in the BRA are summarized below.

- Upland Soil/Waste Rock – All preliminary COCs/COECs identified as risk-drivers in the BRA are included as COCs/COECs.

- Riparian Soil – All preliminary COCs/COECs identified as risk-drivers in the BRA are included as COCs/COECs for evaluation in the FS. In addition, riparian soil and sediment will be combined in the FS; therefore, the COCs/COECs in sediment will be applied to riparian soil.
- Sediment – All preliminary COCs/COECs identified as risk-drivers in the BRA are included as COCs/COECs for evaluation in the FS. In addition, the COCs/COECs in riparian soil also will be applied to sediment.
- Surface Water – Aluminum, barium, boron, and manganese are eliminated as COECs based on background concentrations as described in Section 4.4. In addition, nickel, thallium and zinc are eliminated as COECs based on limited exceedances of screening criteria/regulatory standards (one or two sampling events at two locations including a small seasonal pond [MSP055]). Uranium and vanadium are not retained for further evaluation of COECs due to limited detections above the ecological risk criteria and lack of promulgated criteria or ARARs. Exceedances of ecological risk criteria by these metals were often reported from on-Site pond, spring, and seep stations that will be further evaluated in the FS for metals retained as COCs/COECs. Arsenic, cadmium, and selenium (identified as risk-drivers in the BRA) are included as COCs/COECs for evaluation in the FS.
- Groundwater – Arsenic, cobalt and thallium, were identified in the BRA as preliminary risk drivers. However, these metals are eliminated as COCs as elevated concentrations are isolated and they do not exceed the regulatory-based screening criteria. Both cadmium and selenium are not identified as risk-drivers in the BRA; however, both of these analytes exceed screening criteria/regulatory standards and are considered COCs for evaluation in the FS.

8.0 REFERENCES

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition*. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

Bates, R.L., and Jackson, J.A., 1987. *Glossary of Geology*. American Geological Institute, Alexandria, VA, 788 p.

BLM (U.S. Bureau of Land Management), 1999. *Draft Environmental Impact Statement, Dry Valley Mine-South Extension Project.*

BLM, 2011. *Final - Environmental Impact Statement, Blackfoot Bridge Mine, Caribou County, Idaho*. March 2011.

Butler, B.R. 1986. *Prehistory of the Snake and Salmon River Area*. Handbook of North American Indians, Volume 11: Great Basin, edited by Warren L. D'Azevedo. Pages 127-134. Smithsonian Institution, Washington.

Fenneman, N.M. 1917. *Physiographic Division of the United States:* Assoc. Am. Geographers Annals 6, p. 19 – 98.

Herring, J.R., and R.I. Grauch, 2004. *Lithogeochemistry of the Meade Peak Phosphatic Shale Member of the Phosphoria Formation, Southeast Idaho*. Chapter 12 in Handbook of Exploration and Environmental Geochemistry, Volume 8 - Life Cycle of the Phosphoria Formation: From Deposition to Post-Mining Environment, J.R. Hein editor, Elseveir B.V., Amsterdam, pp. 321 – 366.

Hovland, R.D., 1981. *Geology of the Northwest Part of the Lower Valley Quadrangle Caribou County, Idaho.* San Jose State University Masters Thesis, 108 p.

IDEQ (Idaho Department of Environmental Quality), 2001. *Consent Order/ Administrative Order on Consent: In the matter of Area-Wide Investigation of Contamination from Phosphate Mining in Southeastern Idaho*. Idaho Department of Environmental Quality ("IDEQ"), the United States Environmental Protection Agency ("EPA"), the United States Department of Agriculture ("USDA"), U.S. Forest Service ("USFS"), and the United States Department of Interior ("USDOI"), Bureau of Land Management ("BLM"), U.S. Fish and Wildlife Service ("USFWS"), Bureau of Indian Affairs ("BIA") and the Shoshone-Bannock Indian Tribes; with J.R. Simplot Company, Nu-West Industries, Inc., Rhodia, Inc., FMC Corporation, P4 Production, L.L.C. May, 2001.

IDEQ, 2004a. *Area Wide Risk Management Plan: Removal Action Goals and Objectives, and Action Levels for Addressing Releases and Impacts from Historic Phosphate Mining Operations in Southeast Idaho*, February 2004, IDEQ# WST.RMIN.SEAW.6005.67068.

IDEQ, 2004b. *Memorandum for the Record - Interagency Non-Regulated Surface Water Inspection Results for P4 Production's Ballard, Henry and Enoch Valley Mine Sites*. From Rick Clegg, IDEQ, to Robert Geddes, P4, June 23, 2004, 14 p.

IDEQ, 2004c. *Idaho Risk Evaluation Manual*. Final.

Lee, William H., 2001. *A History of Phosphate Mining in Southeastern Idaho*. CD-ROM Version 1.0. USGS Open-File Report 00-425, Boise, Idaho.

Mabey, D.R. and Oriel S.S., 1970. *Gravity and Magnetic Anomalies in the Soda Springs Region, Southeastern Idaho*. United States Geologic Survey Professional Paper 646E, 15 p.

Mansfield, G.R., 1927. *Geography, Geology, and Mineral Resources of Part of Southwestern Idaho;* with Descriptions of Carboniferous and Triassic Fossils, by G.H. Dirty. U.S. Geological Survey, Professional Paper 152. 453 p.

Mayo, A.L., 1982. *Ground Water Flow Patterns in the Meade Thrust Allochton, Idaho-Wyoming Thrust Belt, Southeastern Idaho*. PhD Dissertation, University of Idaho, May 1982.

Monsanto Chemical Intermediates Company (Monsanto), 1981. *North Henry Amended Operating Plan Federal Lease: ID-011451 Caribou, County, Idaho*. November 1981.

MW (Montgomery Watson), 1998. *Southeast Idaho Phosphate Resource Area Selenium Project – Fall 1997 Interim Surface Water Survey Report*. Prepared by MW for Idaho Mining Association, Selenium Committee, February 1998.

MW, 1999. *1998 Regional Investigation Report, Southeast Idaho Phosphate Resource Area Selenium Project*. Prepared by MW for the Idaho Mining Association, Selenium Committee, December 1999.

MW, 2000. *1999 Interim Investigation Data Report, Southeast Idaho Phosphate Resource Area Selenium Project*. Prepared by MW for the Idaho Mining Association, Selenium Committee, October 2000.

MW, 2001a. *1999-2000 Regional Investigation Data Report for Surface Water, Sediment and Aquatic Biota Sampling Activities, September 1999, Southeast Idaho Phosphate Resource Area Selenium Project*. Prepared by MW for the Idaho Mining Association, Selenium Committee, April 2001.

MW, 2001b. *1999-2000 Regional Investigation Data Report for Surface Water, Sediment and Aquatic Biota Sampling Activities, May – June 2000, Southeast Idaho Phosphate Resource Area Selenium Project*. Prepared by MW for the Idaho Mining Association, Selenium Committee, July 2001.

(Montgomery Watson [MW] merged with Harza Engineering Company in 2001 and became Montgomery Watson Harza, which was shortened to MWH in 2003)

MWH (Montgomery Watson Harza), 2002a. *Spring 2001 Area-Wide Investigation Data Summary*. Prepared by MWH for the Idaho Mining Association, Selenium Committee, March 2002.

MWH, 2002b. *Summer 2001 Area-Wide Investigation Data Summary*. Prepared by MWH for the Idaho Mining Association, Selenium Committee, December 2002.

MWH, 2004. *Field Investigation Update July 2004 Mass Wasting Sampling Effort*. Prepared by MWH for P4 Production, Southeast Idaho Mine-Specific Selenium Program, July 2004.

MWH, 2005. *Chromium Speciation Study in Pond Sediment, Stream Sediment, Stream Riparian Soil, and Waste Rock Dump Soil Memorandum*. Prepared by MWH for P4 Production, Southeast Idaho Mine-Specific Selenium Program, Memo to Rick Clegg. June 2005.

MWH, 2006. *Selenium Speciation Study in Ground Water at Ballard and Henry Mines*. Prepared by MWH of P4 Production, Southeast Idaho Mine-Specific Selenium Program, January 30, 2006.

MWH, 2007. *Interim Phase I SIs Evaluation Summary (Draft),* Prepared by MWH for P4 Production, Southeast Idaho Mine-Specific Selenium Program, November 2007.

MWH, 2008. *Interim Report for Hydrogeologic Investigation, 2007 Hydrogeologic Data Collection Activities and Update Conceptual Models*. Prepared by MWH for P4 Production, Southeast Idaho Mine-Specific Selenium Program, December 2008.

MWH, 2009a. *Culturally Significant Plant Sampling Henry, Ballard, and Enoch Valley Mine Sites Late Summer/Fall 2009*. Technical Memorandum to Mike Rowe, IDEQ, from Cary Foulk and Randy Walsh, MWH. August 2009.

MWH, 2009b. *Supplemental Mine Waste Rock Dump and Facility Soil and Vegetation Characterization Work Plan.* Prepared by MWH for P4 Production, August 2009.

MWH, 2010. *Data Quality and Usability Report (DQUR) and Data Approval Request (DAR).* Final Revision 2, May 2010.

MWH, 2011. *Ballard, Henry and Enoch Valley Mines, Remedial Investigation and Feasibility Study Work Plan*. Final, May 2011.

MWH, 2013a. *Background Levels Development Technical Memorandum*, *Ballard, Henry, and Enoch Valley Mines, Remedial Investigation and Feasibility Study*. Final, March 2013.

MWH, 2013b. *Ballard, Henry, and Enoch Valley Mines, Remedial Investigation and Feasibility Study, 2010-2012 Data Summary Report*, Final, July 2013.

MWH, 2014a. *Ballard, Henry, and Enoch Valley Mines, Remedial Investigation and Feasibility Study, 2013 Data Summary Report*, Final, April 2014.

MWH, 2014b. *Remedial Investigation Report for P4's Ballard Mine. November 2014*.

MWH, 2015a. *Ballard, Henry, and Enoch Valley Mines, Remedial Investigation and Feasibility Study, 2014 Data Summary Report*, Final, February 2015.

MWH, 2015b. *On-Site and Background Areas Radiological and Soil Investigation Summary Report for P4's Ballard, Henry, and Enoch Valley Mines*. Draft, April 2015.

MWH, 2016a. *Ballard Mine Feasibility Study Report, Memorandum 1 Site Background and Screening of Technologies*, Final, May 2016.

MWH, 2016b *Ballard Mine Feasibility Study Report, Memorandum 2 Screening, Detailed, and Comparative Analysis of Assembled Remedial Alternatives*, Draft, July 2016.

Nathan R.J. and McMahon T.A., 1990. *Evaluation of automated techniques for baseflow and recession analysis.* Water Resources Research. 26(7):1465-1473.

NRC (National Academy of Science-National Research Council), 1983. *Selenium in Nutrition*. Rev. ed. Board on Agric., Washington, DC.

Oberlindacher, P., R.D. Hovland, and S.T. Miller, 1982. *Geologic Map of the Aspen Range, Grays Range-Wooley Range, Schmid Ridge, and Webster Range-Dry Ridge known Phosphate Leasing Areas, Southeastern Idaho.* U.S. Geological Survey Open File Report 82-30.

Oberlindacher, P., 1990. *Geologic Map and Phosphate Resources of the Northeastern Part of the Lower Valley Quadrangle, Caribou County, Idaho.* U.S. Geological Survey, Miscellaneous Field Studies Maps, MF-2133.

Oberlindacher, P., R.D. Hovland, and S.T. Miller, J.G. Evans, and R.J. Miller, unpublished. *Geologic Map of the Lower Valley Quadrangle, Caribou County, Idaho.* U.S. Geological Survey, Scientific Investigations Map, publication pending.

O'Kane, 2009a. *Draft - Performance Monitoring of Backfilled Panels and External Overburden Waste Dumps.* Prepared for Idaho Mining Association, Agrium, JR Simplot, & Monsanto, Report No. 745/2-02, May 2009.

O'Kane, 2009b. *Installation Report for the Horseshoe Overburden Area*. Submitted to Monsanto, Report No. 777/6-01, June 2009.

Ralston, D.R., O.M.J. Mohammad, M.J. Robinette, and T.K. Edwards, 1977. *Solutions to Water Resource Problems Associated with Open Pit Mining in the Phosphate Area of Southeastern Idaho.* Completion Report for Groundwater Study Contract No 50-897. U.S. Department of Agriculture, Forest Service, 125 p.

Ralston, D.R., C.M. Wai, T.D. Brooks, M.R. Cannon, T.F. Corbet, H. Singh G.V. Winter, 1980. *Interaction of Mining and Water Resource Systems in the Southeastern Idaho Phosphate Fields.* Idaho Water and Energy Research Institute, University of Idaho, Moscow, Idaho. February 1980.

Ralston, D.R., A.L. Mayo, J.L. Arrigo, J.V. Baglio, L.M. Coleman, J.M. Hubbell, and K. Souder, 1983. *Thermal Ground Water Flow Systems in the Thrust Zone in Southeastern Idaho.* Submitted to Idaho Department of Water Resources. Idaho Water and Energy Research Institute, University of Idaho, Moscow, Idaho. May 1983.

Ralston, D.R., 2010. Review of "Wells Formation Groundwater Review and Scoping Comments". Memorandum to Cary Foulk, MWH, May 24, 2010.

Shoshone-Bannock, 2016. *Exposure Scenario for Use in Risk Assessment*. Shoshone-Bannock Tribes Environmental Waste Management Program. February 2016.

TetraTech, 2002. Final Area Wide Human Health and Ecological Risk Assess*ment, Selenium Project, Southeast Idaho Phosphate Mining Resource Area*. Prepared for Idaho Department of Environmental Quality by TetraTech EM, Inc., December, 2002.

TetraTech, 2008. *Draft - Geochemical Characterization of Phosphate Mining Overburden*. Prepared for the Idaho Mining Association – Idaho Phosphate Working Group, by TetraTech-MFG, Fort Collins, Colorado, February 2008.

U.S. Census, 2010. Census 2010 Demographic Profile Highlights: Soda Springs city, Idaho [Web Page]. Located at http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml. Accessed: January 16, 2013.

USDA (U.S. Department of Agriculture), 1990. *Soil Survey of the Caribou National Forest, Idaho*. USDA-Forest Service in cooperation with USDA, Soil Conservation Service and University of Idaho, 424p.

USEPA (U.S. Environmental Protection Agency), 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final.* EPA/540/G-89/004, Office of Emergency and Remedial Response, October 1988.

USEPA. 1991. R*ole of the Baseline Risk Assessment in Superfund Remedy Selection Decision*. OSWER Directive 9355.0-30.

USEPA, 1997. *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments*. Interim Final. EPA 540-R-97-006. June.

USEPA, 2003. *Consent Order/Administrative Order on Consent for the Performance of Site Investigations (SIs) and Engineering Evaluations/Cost Analyses (EE/CAs) at P4 Production, L.L.C. Phosphate Mine Sites in Southeastern Idaho*. United States Environmental Protection Agency, United States Forest Service, Idaho Department of Environmental Quality, in the Matter of Enoch Valley Mine, Henry Mine, Ballard Mine, P4 Production, L.L.C., respondent, August 20, 2003.

USEPA, 2009. *Administrative Settlement Agreement and Order on Consent/Consent Order for Performance of Remedial Investigation and Feasibility Study at the Enoch, Henry, and Ballard Mine Sites* i*n Southeastern Idaho.* United States Environmental Protection Agency, U.S. EPA Region 10, Idaho Department of Environmental Quality, United States Department of Agriculture, Forest Service Region 4, United States Department of the Interior, Bureau of Land Management, Shoshone-Bannock Tribes, in the Matter of Enoch Valley Mine, Henry Mine, Ballard Mine, P4 Production, L.L.C., Respondent. Effective Date of November 30, 2009

USFWS, 1985, 1997 and 2008 (Section 2.7)

USGS (U.S. Geological Survey) and U.S. Forest Service (USFS), 1977. *Final Environmental Impact Statement, Development of Phosphate Resources in Southeastern Idaho.* Volumes I, II, III, and IV. United State Department of the Interior, Washington, D.C.

Whetstone, 2009. *Final Baseline Geochemical Characterization Study, Blackfoot Bridge Mine EIS*. Prepared for U.S. Department of Interior Bureau of Land Management, on behalf of Monsanto Corporation / P4 Production Blackfoot Bridge Mine, December 2008.

Winter, G.V., 1980. *Groundwater Flow Systems of the Phosphate Sequence, Caribou County, Idaho.* M.S. Thesis, University of Idaho.

TABLES

SECTION 2.0 TABLES

TABLE 2-1 HENRY SITE WASTE ROCK DUMP AND MINE PIT AREAS AND VOLUMES				
Waste Rock Dump/ Mine Pit	**Net Fill(1) (cu. yd.)**	**Net Cut(2) (cu. yd.)**	**2D Area(3) (sq. ft.)**	**3D Area(4) (sq. ft.)**
MWD085	2,500,000	---	2,850,000	2,890,000
MWD086	11,200,000	---	12,100,000	12,400,000
MWD087	6,570,000	---	3,760,000	3,870,000
MWD088	3,650,000	---	3,190,000	3,260,000
MWD090	8,390,000	---	4,340,000	4,480,000
MMP041(5)	---	6,500,000	4,230,000	4,900,000
MMP042	---	837,000	1,640,000	1,700,000
MMP043	---	11,500,000	6,140,000	6,610,000
MMP044(5)	---	13,600,000	3,960,000	4,640,000
TOTAL	**32,300,000**	**32,400,000**	**42,200,000**	**44,800,000**
Acres:			**969**	**1,030**

Notes:
Calculated areas and volumes have been rounded to three significant figures.
(1) - Fill volumes and areas are for the external waste rock dumps; the portion of the dump within mine pit boundaries is not included.
(2) - Net cut volume is from below original grade and does not include backfilled volume of the mine pits.
(3) - 2D area is the area in a horizontal map view.
(4) - 3D area is the surface area that accounts for the topography.
(5) - Pits MMP041and MMP044 contain un-backfilled volume.
--- = not applicable

TABLE 2-2 ENOCH VALLEY SITE WEATHER STATION METEOROLOGICAL DATA[a]													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Avg. Monthly Precipitation (in.)	2.34	1.99	1.51	1.58	2.26	1.70	0.51	1.04	1.30	1.65	1.36	1.75	19.0
Avg. Monthly Min. Temperature (ºF)	-12.9	-11.4	-7.30	6.97	20.4	26.7	34.3	32.5	22.7	11.8	1.98	-13.7	9.34
Avg. Monthly Temperature (ºF)	16.0	19.2	26.3	34.9	46.0	54.4	64.8	60.2	49.3	38.1	28.5	19.8	38.1
Avg. Monthly Max. Temperature (ºF)	41.8	44.5	52.4	64.8	74.0	81.4	89.1	86.9	81.3	68.4	55.3	43.9	65.3

Notes:
a - Data is derived from the Enoch Valley Site weather station climate readings compiled from 1997-2000 and 2005-2008.

TABLE 2-3 HENRY SITE SURFACE WATER DISCHARGES									
	Year	Long Valley Creek		Little Blackfoot River			Lone Pine Creek		
		MST050(1)	MST051(2)	MST044(3)	MST045(4)	MST234	MST063	MST057	MST054
Annual Runoff Discharge (cfs)	2004	--	Dry	1.82	1.79	7.1	--	0.044	0.19
	2006	0.88	Dry	--	--	23.0	0.03	0.939	--
	2007	0	Dry	2.5	2.2	10	0.0066	0.1824	0.37
	2008	0.0013	Dry	4.8	6.5	12	Dry	0.50813	0.95
	2009	1.14	0.019	33.9	36.4	--	0.0094	2.69	--
	2010	0.02	Dry	4.83	6.04	--	0.021	0.31	--
	2012	0.13	Dry	8.38	7.11	--	0.0053	0.00086	--
	2013	0.15	Dry	7.84	8.89	--	0.012	0.10646	--
	2014	0.0024	Dry	8.72	9.72	--	0.017	0.214	--
Annual Baseflow Discharge (cfs)	2004	--	--	--	--	--	--	--	--
	2006	--	--	--	--	--	--	--	--
	2007	0	Dry	1.5	1.5	7.0	Dry	0	0.13
	2008	--	Dry	0.59	0.80	7.5	Dry	0.00337	0.26
	2009	--	--	2.79	1.9	--	--	--	--
	2010	--	--	1.97	2.6	--	--	--	--
	2012	--	--	3.12	4.47	--	--	--	--
	2013	--	--	1.3	1.29	--	--	--	--
	2014	--	---	1.64	1.12	--	--	--	--

Notes:
(1) MST050 is located approximately 1000 feet upstream of the Site on Long Valley Creek.
(2) MST051 is located immediately downstream of the Site on a tributary to Long Valley Creek.
(3) MST044 is located immediately upstream of the Site
(4) MST045 is located immediately downstream of the Site
cfs = cubic feet per second
Dry = no water present
0 = water present but there was no observed flow or flow was so small as not to be measurable with standard equipment.
-- = Location not included in sampling program for this year.

- Stations are arranged with upstream locations listed first.
- Runoff measurement are typically in May and baseflow measurements are typically in September.
- Monitoring locations shown on Drawing 2-1.

TABLE 2-4
HENRY SITE SPRING AND SEEP DISCHARGES

	Year	Dump Seeps			Springs
		MDS016	MDS022	MDS034	MSG002
Annual Runoff Discharge (cfs)	2004	N/A	0.0011	--	Dry
	2006	0.0088	0.036	--	0.011
	2007	<0.0001	0.014	--	0.00096
	2008	--	N/A	N/A	Dry
	2009	--	--	0	--
	2010	--	--	N/A	--
	2013	--	--	0.0015	--
	2014	--	--	0.0033	--
Annual Baseflow Discharge (cfs)	2004	--	--	--	--
	2006	Dry	0.09	--	0.0062
	2007	Dry	0.0015	--	Dry
	2008	Dry	0.016	Dry	0.0036
	2012	--	--	Dry	--

Notes:
cfs = cubic feet per second
Dry = no water present
N/A = Site sampled, but a flow measurement was not collected.
0 = water present but there was no observed flow or flow was so small as not to be measurable with standard equipment.
-- = Location not included in sampling program for this year.

TABLE 2-5
HENRY SITE SPRING, SEEP, AND STREAM HEADWATER RECESSION CONSTANT (*K*) VALUES

	Average	Final
MDS016	0.932	0.932
MDS022	0.990	1.014
MSG002	0.992	0.989

Notes:
Average – the average recession constant of each time-step on the hydrograph.
Final – the recession constant for the final time-step in the hydrograph.
The recession constant K is unitless

TABLE 2-6
HENRY SITE PONDS

Pond	Site ID	Approx. Area (acres)	Perennial	Potential Overflow Location	Use/Features
Henry Pond	MSP014	5.8	Yes	In Lone Pine Creek watershed but no observed outfall.	No riparian vegetation.
Smith Pond	MSP015	1.3	No	In Little Blackfoot River watershed but no observed outfall.	Adjacent to Henry haul road, supports some willows, used by livestock.
Center Pond	MSP016	0.71	Yes	In Little Blackfoot River watershed but no observed outfall.	Below waste rock, supports few willows.
South Pit Pond	MSP055	0.12	No	Closed basin	Open pit pond, small, no riparian vegetation.

TABLE 2-7
GENERALIZED STRATIGRAPHY OF THE PROJECT AREA [1]

AGE		FORMATION	MEMBERS	GENERAL DESCRIPTION	HYDROGEOLOGIC CHARACTERISTICS [2]
CENOZOIC	Quaternary	ALLUVIUM (Qal and Qw)	--	Alluvium or colluvium.	Supports local groundwater flow system.
	Quaternary/ Tertiary	BASALT (Qb)	--	Basalt flows, basalt ash.	Can support intermediate groundwater flow system where fractured, but generally supports local systems.
MESOZOIC	Triassic	THAYNES (TRt)	Several Members	Mostly limestone with sandstone layers. Some siltstone and shale members.	Typically, supports intermediate groundwater flow system.
		DINWOODY FM (TRd)	Upper Unit	Gray, fossiliferous limestone interbedded with olive-brown calcareous siltstone.	Typically, supports intermediate groundwater flow system.
			Woodside Shale	Reddish-brown siltstone and shale. Discontinuous in the mine area.	Does not support groundwater flow system.
			Lower Unit	Olive-brown calcareous siltstone and shale with thin-bedded limestone.	Typically supports intermediate groundwater flow system.
PALEOZOIC	Permian	PHOSPHORIA FM (Pp)	Retort Phosphatic Shale	Phosphatic shale. Discontinuous in area of Site.	Does not support groundwater flow system. Low hydraulic conductivity layer.
			Cherty Shale	Thin-bedded dark-brown to black cherty mudstone, siliceous shale and argillaceous chert.	Does not support groundwater flow system. Low hydraulic conductivity layer.
			Rex Chert	Thick-bedded black to white chert with some mudstone and some limestone lenses.	May support isolated groundwater flow in highly fractured areas.
			Meade Peak Phosphatic Shale (Ppm)	Dark-brown to black mudstone, limestone and phosphorite. Meade Peak member is typically mined.	Does not support groundwater flow system. Low hydraulic conductivity layer.
	Permian/ Pennsylvanian	PARK CITY FM [3]	Grandeur Limestone	Light gray dolomite and cherty dolomite with some sandstone. Discontinuous in area of Site. Mapped with Wells Fm.	Does not appear to be present at the Site.
		WELLS FM (ℙw)	Upper Unit (ℙwu)	Light gray to reddish-brown sandstone, some interbedded limestone and dolomite.	Supports groundwater flow systems, which may be regional.
			Lower Unit (ℙl)	Medium bedded gray cherty limestone, some interbedded sandstone.	Supports groundwater flow systems, which may be regional.
	Mississippian	BRAZER OR MONROE CANYON FM (Mb)	Brazer Limestone	Light gray limestone with interbedded sandstone, occasionally with grey and green shale. Not exposed or intersected by drilling in the area of the Site.	Does not outcrop in the vicinity of the Site.

Notes:
1. Stratigraphy based on Ralston, et al., 1980 and Ralston, et al., 1983.
2. Notes on hydrologic characteristics are based on several sources of information. Information not available for all units.
3. Often mapped as part of the Wells Formation.

TABLE 2-8 HYDRAULIC CONDUCTIVITY TESTING RESULTS FOR SITE MONITORING WELLS					
	Units	**MMW011**	**MMW014**	**MMW023**	**MMW028**
Formation:		Wells	Alluvium	Wells	Dinwoody
Hydraulic Conductivity	ft/sec	2.0E-05	1.9E-05	6.6E-04	1.0E-03
	ft/day	1.7E+00	1.6E+00	5.7E+01	8.6E+01
	cm/sec	6.1E-04	5.8E-04	2.0E-02	3.0E-02

TABLE 2-9 OCTOBER – APRIL PRECIPITATION AT BLACKFOOT BRIDGE AND ENOCH VALLEY MET STATIONS		
	Precipitation (inches)	
Water Year	Blackfoot Bridge Mine	Enoch Valley Mine
2004/2005	10.85	13.31
2005/2006	11.91	18.41
2006/2007	8.88	13.08
2007/2008	5.94	13.93
2008/2009	9.51	18.60
2009/2010	6.74	12.92
2010/2011	12.10	24.71
2011/2012	8.15	13.77
2012/2013	6.94	14.53

TABLE 2–10 TRACE ELEMENT CONCENTRATIONS IN MEADE PEAK MEMBER AND TYPICAL SHALE		
Element	**Average Concentrations in Meade Peak Section (mg/kg or ppm)**	**Average Concentration for Typical Shale (mg/kg or ppm)**
Selenium	39 to 68	0.8
Cadmium	22 to 112	0.3
Chromium	525 to 1470	100
Silver	4 to 14	0.1
Uranium	26 to 108	3
Zinc	763 to 3,349	150

TABLE 2-11
SUMMARY STATISTICS FOR MEADE PEAK MEMBER SAMPLES

Element	Mean	Standard Deviation	Minimum	Maximum	Sample Count (n)	RI Soil Background Level
Arsenic	26	31	5	400	209	15.6
Cadmium	59	88	1	590	278	41.0
Chromium	1,038	1,064	21	10,000	279	410
Cobalt	9.2	9.9	1	108	212	13.0
Copper	86	75	1	540	279	51.9
Molybdenum	49	90	1	694	276	29.0
Nickel	206	193	10	1,400	279	220
Selenium	61	68	0.7	406	216	29
Silver	5.1	4.9	1	36	225	1.70
Uranium	51	54	<100	328	180	36.0
Vanadium	538	926	12	11,000	279	300
Zinc	1208	1,440	13	9,400	279	1200

Notes:

All concentrations in mg/kg.

Data and statistics from Perkins and Piper (2004).

Sample analysis by ICP-AES or ICP-MS except for selenium and arsenic which were by hydride generation-AAS.

SECTION 3.0 TABLES

TABLE 3-1
HENRY SITE RI SAMPLING SUMMARY

	Surface Water	Groundwater	Direct Push Groundwater	Sediment	Salmonids	Forage Fish	Benthic Macroinvertebrates	Riparian Soil	Riparian Vegetation	Upland Soil	Upland Vegetation	Cattle	Bird Eggs	Elk	Small Mammals	Terrestrial Invertebrates
Pre-2004	♯	-	-	♯	-	-	-	-	-	♯	♯	ϕ	ϕ	ϕ	♯	♯
May 2004	22	2	-	22	$0^{\#}$	3	-	-	-	-	1	-	-	-	-	-
June 2004	-	-	-	-	-	-	17	-	-	-	1	-	-	-	-	-
July 2004	-	-	-	-	-	-	-	-	-	52	53	-	-	-	-	-
August 2004	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
September 2004	5	-	-	-	-	-	-	28	28	-	1	-	-	-	-	-
October 2004	-	3	-	-	-	-	-	-	-	-	1	-	-	-	-	-
June 2005	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
October 2005	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
May 2006	18	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
May 2007	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
September 2007	7	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
October 2007	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
May 2008	10	9	1	-	-	-	-	-	-	-	-	-	-	-	-	-
June 2008	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-
September 2008	9	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-
May 2009	6	2	4	-	-	-	-	-	-	-	-	-	-	-	-	-
June-July 2009	-	7	-	-	-	-	-	-	-	70	124	-	-	-	-	-
August 2009	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-	-
September 2009	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
May 2010	5	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
August 2010	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
September 2010	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sept.-Oct. 2010	7	-	-	5	-	-	-	5	-	-	-	-	-	-	-	-
July-Aug. 2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
May 2012	5	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
September 2012	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
April-May 2013	7	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
September 2013	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
May 2014	7	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
September 2014	2	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-

Notes:

The total numbers of stations sampled per sampling event are provided.

♯ - Data were collected in the Site area during regional studies, but for these media the data have not been validated for use in the RI.

ϕ - A large number of elk and bird egg data were collected in 1999 – 2001 and these data are available for risk evaluations if needed. In addition, a study of cattle was conducted at the Henry Mine, which may have relevance to the Site RI and BRA.

$0^{\#}$ - Fish sampling was conducted but no salmonid fish were located in the Site area.

TABLE 3-2
SUMMARY OF ANALYTICAL PARAMETERS BY MEDIUM

	Surface Water		Groundwater		Direct Push Shallow Groundwater (BH)		Direct Push Shallow Groundwater (MBWs)		Sediment	Riparian Soil	Riparian Vegetation	Upland Soil	Upland Vegetation	Salmonids	Forage Fish	Benthic Macroinvertebrates	Cattle	Bird Eggs	Elk
	T	D	T	D	T	D	T	D											
Aluminum	X	X	X	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	X	X	X	X	--	--	--	--	X	X	--	X	X	--	--	--	--	--	--
Arsenic	X	X	X	X	--	--	--	--	X	X	--	X	X	--	--	--	--	--	--
Barium	X	X	X	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	X	X	X	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	X	X	X	X	--	--	--	--	X	X	--	X	X	--	--	--	--	--	--
Cadmium	X	X	X	X	--	--	X	X	X	X	X	X	X	X	X	--	X	X	X
Calcium	X	X	X	X	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--
Chloride	--	X	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	X	X	X	X	--	--	--	--	X	X	--	X	X	--	--	--	--	--	--
Cobalt	X	X	X	X	--	--	--	--	X	X	--	X	X	--	--	--	--	--	--
Copper	X	X	X	X	--	--	--	--	X	X	X	X	X	--	--	--	X	--	X
Fluoride	--	X	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Gross Alpha	X	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Gross Beta	X	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	X	X	X	X	--	--	--	--	--	--	--	--	--	--	--	--	X	--	X
Lead	X	X	X	X	--	--	--	--	--	--	--	--	--	--	--	--	X	--	X
Magnesium	X	X	X	X	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--
Manganese	X	X	X	X	--	--	X	--	X	X	--	X	X	--	--	--	X	--	X
Mercury	X	X	X	X	--	--	--	--	X	X	--	X	X	--	--	--	--	--	--
Molybdenum	X	X	X	X	--	--	--	--	X	X	X	X	X	--	--	--	--	--	--
Nickel	X	X	X	X	--	--	--	--	X	X	--	X	X	X	X	--	--	--	--
Nitrite/Nitrate as N	X	--	X	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE 3-2
SUMMARY OF ANALYTICAL PARAMETERS BY MEDIUM (continued)
Page 2 of 2

	Surface Water		Groundwater		Direct Push Shallow Groundwater (BH)		Direct Push Shallow Groundwater (MBWs)		Sediment	Riparian Soil	Riparian Vegetation	Upland Soil	Upland Vegetation	Salmonids	Forage Fish	Benthic Macroinvertebrates	Cattle	Bird Eggs	Elk
	T	D	T	D	T	D	T	D											
Nitrogen - Kjeldahl	X	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--
Phosphorus (ortho)	--	X	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	X	X	X	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	X	X	X	X	--	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Selenium (extractable)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium (selenite)	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium (selenate)	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	X	X	X	X	--	--	--	--	X	X	--	X	X	--	--	--	--	--	--
Sodium	X	X	X	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sulfate	--	X	--	X	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--
Total Dissolved Solids (TDS)	X	X	X	X	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	X	X	X	X	--	--	--	--	X	X	--	X	X	--	--	--	--	--	--
Total Organic Carbon (TOC)	X	--	X	--	--	--	--	--	X	X	--	X	X	--	--	--	--	--	--
Total Alkalinity	X	X	X	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Suspended Solids (TSS)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Uranium	X	X	X	X	--	--	--	--	X	X	--	X	X	--	--	--	--	--	--
Vanadium	X	X	X	X	--	--	--	--	X	X	--	X	X	X	X	--	--	--	--
Zinc	X	X	X	X	--	--	--	--	X	X	X	X	X	X	X	--	X	--	X
Number of Sample Events	17	17	15	15	3	3	1	1	2	2	2	2	2	1	1	1	1	3	2

Notes:
T - Total Fraction, D - Dissolved Fraction
X - Constituent was analyzed for in at least one event that the medium was sampled
-- - Never sampled for in this medium

TABLE 3-3 HENRY SITE SURFACE WATER MONITORING LOCATIONS				
Location	Type	Description	Years Sampled	# of Samples
Lone Pine Creek Drainage				
MST054*	Stream	Lone Pine Creek	04, 07, 08	5
MST055*	Stream	Lone Pine Creek	04	1
MST056	Stream	Lone Pine Creek	06	1
MST057*	Stream	W. Fork above Lone Pine Creek	04, 06-10, 12-14	11
MST058*	Stream	Lone Pine Creek	04, 06	3
MST062*	Stream	Strip Mine Creek below mine	04	1
MST063*	Stream	Strip Mine Creek below mine	04, 06-07, 09-10, 12-14	8
MST064*	Stream	W. Fork above Lone Pine Creek	04, 06	3
MST226	Stream	Tributary to Lone Pine Creek	06, 12-14	4
MST275*	Stream	Tributary to Lone Pine Creek	04, 06, 10, 13,14	6
MST276*	Stream	Tributary to W. Fork Lone Pine Creek	04, 06-08	7
MST280	Stream	Creek across MWD088	08	1
Long Valley Creek Drainage				
MST051	Stream	E. Fork Long Valley Creek below mine	09	1
MST271	Stream	Long Valley Creek below E. Fork	06	1
Mine Area				
MSG002	Spring	Taylor Spring	06-08	3
MDS016*	Dump Seep	Dump Seep	04, 06, 07	3
MDS022*	Dump Seep	Dump Seep (Limestone Drain)	04, 06-08	7
MDS034	Dump Seep	Dump Seep #3	08-10, 13, 14	5
MSP014*	Pond	On waste rock dump MWD085	04, 06, 08, 10	4
MSP015*	Pond	On waste rock dump MWD086	04, 06, 10	3
MSP016*	Pond	On waste rock dump MWD085	04, 06, 10	3
MSP055*	Pond	South Pit Pond	04, 06-08	4
Little Blackfoot River				
MST052	Stream	Henry Creek, above Little Blackfoot	06	1
MST053*	Stream	River, below Enoch Valley Creek	04, 10	2
MST234*	Stream	River immediately above Blackfoot Res.	04, 06-08	6
MST043*	Stream	River below Long Valley and mine	04	1
MST044*	Stream	River immediately below mine	04, 07-10, 12-14	15
MST045*	Stream	River above Henry Creek and mine	04, 07-10, 12-14	15
MST046*	Stream	River, below Enoch Valley Creek	04	1
MST047*	Stream	River, above Enoch Valley Creek	04	1
Total Samples Collect Between 2004 – 2014				**127**

Notes:
*Denotes station where sediment samples were collected in 2004 or 2010.

TABLE 3-4
HENRY SITE GROUNDWATER MONITORING LOCATIONS

Location	Type	Description	Years Sampled	# of Samples	Notes
Alluvial Direct-Push Borehole Wells					
MBW152	1” M. Well	North Henry Mine, Along Little Blackfoot River	09-10, 12-14	5	
Monitoring Wells					
MMW003	2” M. Well	South of Henry Mine north pit (MMP043)	--	0	Abandoned
MMW004	2” M. Well	North of Henry Mine north pit (MMP043)	04-09	9	
MMW010	2” M. Well	Southeast of Center Henry Pit; near MPW023	07-10, 12-14	10	
MMW011	2” M. Well	Northwest of Center Henry Pit; south of Little Blackfoot River	07-10, 12-14	8	
MMW014	2” M. Well	Southeast of Henry Mine center pit in Lone Pine Creek alluvial flow field	07-09	4	
MMW019	2” M. Well	North of Henry Mine center pit	07-09	4	
MMW022	2” M. Well	Northeast lobe of Henry Mine waste rock dump MWD086	07-10, 12-14	8	
MMW023	2” M. Well	Henry Mine North Pit (MMP041)	07-10, 12-14	8	
MMW028	2” M. Well	Near the Little Blackfoot River northwest of MMW019	08-10, 12-14	6	
Agricultural, Domestic, and Production Wells					
MAW001	Agricultural	School Bus Well	04, 08, 12	3	Background
MAW003	Agricultural	(b) (6) Field Well	04, 08, 12	3	Background
MAW004	Agricultural	Dredge Field Well	04, 08	2	Background
MAW006	Agricultural	(b) (6) Field Well West	04, 08, 12	3	Background
MAW007	Agricultural	(b) (6) Field Well North	04, 08	2	Background
MDW001	Domestic	(b) (6) House Well	04, 08, 12	3	Background
MDW003	Domestic	(b) (6) House Well	04, 08, 12	3	Background
MDW005	Domestic	Cedar Bay RV Park Well	04, 08, 12	3	Background
MPW022	Production	South Henry Pit dewatering well	04-08	8	
MPW023	Production	Center Henry Pit dewatering well	04-08	5	

Notes:
Sample coordinates are provided in the RI/FS Work Plan Appendix A

TABLE 3-5
HENRY SITE MONITORING, DIRECT-PUSH, AND OTHER WELL DETAILS

Well ID	Well Location	Date Installed	Formation Screened	Ground Surface Elevation (ft-AMSL)	Boring TD (ft bgs)	Depth Water Encountered when Drilling (ft bgs)	Depth to Formation Contacts (ft bgs)	Well Completion TD (ft bgs)	Screened Interval [Length] (ft bgs)
MBW152	North Henry Mine, Along Little Blackfoot River	5/12/2009	Alluvium	6280.00	15	7.5	0-Alluvium	15	15-10 [5]
MMW004	South of Henry Mine North Pit (MMP043)	Unknown	Unknown	NA	77	Unknown	Unknown	55[a]	No screen
MMW010	Southeast of Center Henry Pit; near MPW023	9/9/2007	Alluvium	6462.62	38	17	0-Alluvium	32	32-12 [20]
MMW011	Northwest of Center Henry Pit; south of Little Blackfoot River	9/8/2007	Wells	6268.31	120	101	0-Wells	115	115-95 [20]
MMW014	Southeast of Henry Mine center pit in Lone Pine Creek alluvial flow field	8/11/2007	Alluvium	6435.45	22	9	0-Alluvium	22	22-7 [15]
MMW019	North of Henry Mine Center Pit	8/10/2007	Phosphoria	6259.92	14	10	0-Phosphoria	14	14-4 [10]
MMW022	Northeast lobe of Henry Mine waste rock dump MWD086	7/28/2007	Dinwoody	6635.85	360	320, 340	0-Waste Rock 5-Dinwoody	326	326-306 [20]
MMW023	Henry Mine North Pit (MMP041)	9/11/2007	Wells	6266.94	362	128, 188	0-Phosphoria 350-Wells	357	357-352 [5]
MMW028	Near the Little Blackfoot River northwest of MMW019	7/15/2008	Dinwoody	6316.91	100	80, 100	0-Alluvium 40-Basalt 63-Alluvium 70-Dinwoody	96	96-76 [20]
MPW022	South Henry Pit dewatering well	1980	Phosphoria ?	6534.31	165	63	Unknown	165	Casing to 151
MPW023	Center Henry Pit dewatering well	Unknown	Phosphoria ?	6460.00	312	Unknown	Unknown	312	Casing to 160

[a] Casing depth noted
ft-AMSL: feet above mean sea level
ft-bgs: feet below ground surface

TABLE 3-6
DIRECT-PUSH BOREHOLE COMPLETION DATA

Borehole ID	Date	Surface Elev. (ft-AMSL)	Water Level (ft-BGS)	Total Depth (ft-BGS)	Notes
BH029	5/22/2008	6440	Dry	NA	cored borehole
BH030	5/22/2008	6447	Dry	15	
BH055	5/31/2008	6280	Dry	55	cored borehole
BH056	6/01/2008	6273	Dry	18	
BH057A	6/01/2008	6276	Dry	6	refusal
BH057B	6/01/2008	6273	Dry	4	refusal
BH058	6/01/2008	6287	4	28	cored borehole
BH059	6/01/2008	6312	23	25	
BH060	6/01/2008	6286	Dry	13	refusal
BH061	6/02/2008	6372	Dry	19	refusal
BH062	6/02/2008	6377	Dry	17	refusal
BH063	6/02/2008	6391	20.5	20	
BH072	6/04/2008	6358	Dry	45	cored borehole
BH073	6/04/2008	6444	4	20	
BH074	6/04/2008	6437	7	15	
BH075	6/04/2008	6401	Dry	10	cored borehole
BH076	6/04/2008	6437	9	10	
BH077	6/04/2008	6430	1	10	
BH078	6/04/2008	6409	Dry	35	cored borehole
BH079	6/04/2008	6378	NA	25	
BH150	5/12/2009	6321	Dry	11.5	refusal
BH151	5/12/2009	6306	2	15	
BH/MBW152	5/12/2009	6303	7.5	15	well: TD 15, screen 10-15
BH153	5/12/2009	6303	1.5	20	
BH157	5/12/2009	6435	2	10	
BH158	5/12/2009	6424	0.5	10	
BH167	8/17/2010	NA	7	15	
BH168	8/17/2010	NA	Dry	30	
BH169	8/17/2010	NA	7.5	13	
BH170	8/17/2010	NA	Dry	30	
BH171	8/17/2010	NA	9	13	

Notes:
NA = Not available

SECTION 4.0 TABLES

TABLE 4-1
PRELIMINARY COC/COEC UPLAND SOIL CONCENTRATION SUMMARY

Analyte	Arsenic	Cadmium	Chromium	Copper	Molybdenum	Nickel	Selenium	Thallium	Vanadium	Zinc
Background[1]	15.6	41.0	410	51.9	29.0	220	29.0	1.10	300	1200
MBH002[2]	6.6-9.0	0.572-1.15	17.2-23.1	21.2-28.7	<1.08-<1.15	22.8-27.2	0.477-1.26	0.139-0.163	22.2-27.1	57.7-93.1
MHR002	7.2-45.5	19.4-59.5	70.2-332	22.9-168	3.87-28.7	78.5-293	7.45-57.1	0.839-2.22	77.1-556.2	407-944
MWD085	4.89-40.7	3.74-46.6	22.2-499	15.7-147	<1.14-26.2	26.4-282	<0.5-91.8	0.232-2.08	24.9-300	138-1220
MWD086	4.0-33.4	2.13-48.9	19.9-456	11.1-148	<1.05-23.0	22.5-320	0.687-59.6	0.171-1.66	22.3-386	121-1240
MWD087	16.0-32.1	24.8-47.5	214-383	93.9-172	7.08-35.7	166-350	12.0-96.2	0.828-2.31	165-273	825-1430
MWD088	7.92-44.5	6.33-58.2	40.3-501	35.0-135	1.41-28.4	41.9-345	2.62-55.4	0.333-1.91	38.7-584	199-1320
MWD090	7.89-34.9	12.6-45.5	41.9-519	26.4-148	4.27-23.8	88.9-425	8.45-318	0.736-1.59	81.8-412	403-1610

Notes:

[1]Background levels for the P4 Sites were determined based on a 95% UTL as presented in *Background/Radiological Report* (MWH, 2015b). Levels are inclusive of all soil formed on all strata within the P4 Sites.

[2]Henry Mine site-specific background area. Data were included in the determination of P4 Sites background (MWH, 2015b)

Concentrations in mg/kg.

Shaded results indicate those which ranges contain exceedances of a background level.

Complete data table is provided in Appendix B, Table B-1.

MBH – mine background Henry

MHR – mine haul road

MWD – mine waste rock dump

TABLE 4-2
RADON FLUX DATA AND CALCULATED INDOOR AIR CONCENTRATIONS

Field ID	Radon-222 pCi/m^2-s	Radon-222 Uncertainty pCi/m^2-s	Converted Indoor Air Radon Concentration (pCi/L)
1410-H1	3.55	0.16	5.20
1410-H2	9.10	0.21	13.33
1410-H3	1.58	0.13	2.32
1410-H3 Dup	3.17	0.12	4.64
1410-H4	4.83	0.16	7.07
1410-H5	2.73	0.13	3.99
1410-H6	5.58	0.14	8.17
1410-H7	3.44	0.14	5.04
1410-H8	6.73	0.16	9.85
1410-H9	3.97	0.12	5.81
1410-H10	2.01	0.09	2.94
1410-H11	1.35	0.08	1.98
1410-H11 Dup	2.79	0.14	4.08
1410-H12	3.41	0.08	5.00
1410-H13	3.28	0.15	4.81
1410-H14	7.74	0.18	11.32
1410-H15	3.34	0.15	4.89

Notes:
pCi/m2/s – picoCuries per meter squared second
pCi/L – picoCuries per liter
Dup - duplicate

TABLE 4-3 PRELIMINARY COC/COEC UPLAND VEGETATION – GRASS AND FORBS CONCENTRATION SUMMARY						
Analyte	**Arsenic**	**Cadmium**	**Molybdenum**	**Selenium**	**Thallium**	**Uranium**
Background	NC	1.70	5.78	3.41	0.0163	0.162
MBH002	<0.0713-6.67	<0.0238-0.483	<1.49-2.87	0.241-1.12	<0.00924-<0.00998	<0.09924-<0.0998
MHR002	<0.073-1.53	0.553-3.7	<1.46-18.8	1.27-49.0	0.0958-0.664	<0.1-0.173
MWD085	<0.075-0.248	0.587-5.08	5.55-58.4	0.717-19.2	0.0848-0.24	<0.0924-<0.1
MWD086	<0.0744-0.61	0.254-1.66	4.74-13.3	0.765-46.0	0.0163-0.235	<0.0928-<0.0992
MWD087	<0.0749-1.28	0.654-5.29	10.2-125	0.451-146	0.0587-0.713	<0.0998-0.207
MWD088	<0.0749-0.988	0.444-2.91	1.53-14.9	0.472-20.2	<0.01-0.461	<0.1-1.27
MWD090	<0.0697-1.2	0.361-2.61	2.33-24.9	1.15-139	0.0264-0.426	<0.0917-<0.178

Notes:
[1]Background levels were calculated using the 95% USL
Concentrations in mg/kg dry weight.
Shaded results indicate those which ranges contain exceedances of background level.
Complete data table is provided in Appendix B, Table B-2.
NA = not available
NC = not calculated

TABLE 4-4
2009 SEASONAL FORB SELENIUM AND MOLYBDENUM CONCENTRATIONS

Sample Location	Selenium		Diff.	Molybdenum		Diff.
	Spring	Fall		Spring	Fall	Fall
MBH002-05	0.518	1.63	215%	<1.48	<1.47	-1%
MBH002-08	0.291	0.832	186%	<1.49	<1.47	-1%
MBH002-10	0.492	0.392	-20%	<1.50	1.91	
MHR002-04	2.58	1.28	-50%	3.06	1.56	-49%
MHR002-10	49.0	4.10	-92%	13.1	2.91	-78%
MWD085-02	2.31	2.48	7%	7.53	5.4	-28%
MWD085-03	6.29	9.81	56%	15.9	10.9	-31%
MWD086-07	2.17	4.82	122%	9.59	10.7	12%
MWD087-06	0.856	7.56	783%	110	3.78	-97%
MWD088-02	20.2	5.61	-72%	7.24	6.87	-5%
MWD088-09	3.36	3.29	-2%	5.05	1.71	-66%
MWD090-02	2.77	2.62	-5%	2.95	4.47	52%
MWD090-04	67.6	69.1	2%	22.1	23.8	8%

Notes:
Concentrations in mg/kg dry weight.
Background level for selenium is 3.41 mg/kg and for molybdenum is 5.78 mg/kg.
Shaded results indicate those which are seasonally higher.
Complete data table is provided in Appendix B, Table B-2.

TABLE 4-5
CULTURALLY SIGNIFICANT VEGETATION SAMPLE CONCENTRATIONS AND EXCEEDANCES[1]

	Selenium (mg/kg dw)	Uranium (mg/kg dw)
Background Level	**3.41**	**0.162**
Background Locations		
MBH002 JUSC-LEAF	0.181	<0.0988
MBH002 JUSC-STEM	0.192	<0.0963
Waste Rock Dump Locations		
MWD086 POTR-LEAF	5.26	<0.0984
MWD086 POTR-STEM	1.23	<0.0986
MWD086 ARTR-LEAF	0.643	<0.0986
MWD086 ARTR-STEM	0.504	<0.0986
MWD087 ARLU	1.78	<0.0978

Notes:
mg/kg dw – milligram per kilogram dry weight
ARLU - white sagebrush (*Artemisia ludoviciana*)
ARTR - big sagebrush (*Artemisia tridentata*)
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
Shaded results indicate an exceedance of background levels.
<0.0### = Concentration less than or equal to the method detection limit shown.
Complete data table is provided in Appendix B, Table B-2.

TABLE 4-6
RIPARIAN SOIL AND SEDIMENT PRELIMINARY COC/COECs CONCENTRATIONS IN SITE PONDS

Pond	Analyte	Riparian Soil Bckgrnd . Value	Sediment Bckgrnd. Value	Sampling Event			
				Riparian Soil Spring 04	Riparian Soil Fall 2010	Sediment Spring 2004	Sediment Fall 2010
MSP014	Selenium	2.03	1.48	11.5	--	18.9	4.9-46.2
	Cadmium	5.02	4.17	5.78	--	21	2.6-28.1
	Chromium	43.3	38.1	48.4	--	222	23.1-144
	Copper	24.3	25.5	23.3	--	--	27.5-46.6
	Molybdenum	0.653	0.500	3.25	--	--	2.2-10.8
	Nickel	29.6	28.7	42.6	--	104	27.5-148
	Uranium	3.85	2.37	--	--	--	2.9-30.2
	Vanadium	57.9	49.1	65	--	181	35.4-174
	Zinc	180	166	231	--	621	126-979
MSP015	Selenium	2.03	1.48	24	--	22	26.5-43.4
	Cadmium	5.02	4.17	5.67	--	10.5	11.9-22.9
	Chromium	43.3	38.1	46.2	--	53	52.2-77.4
	Copper	24.3	25.5	21.8	--	--	32.9-68.8
	Molybdenum	0.653	0.500	1.41	--	--	3.0-5.3
	Nickel	29.6	28.7	48	--	85.6	95.2-165
	Uranium	3.85	2.37	--	--	--	7.2-12.6
	Vanadium	57.9	49.1	66.1	--	66	65.4-101
	Zinc	180	166	268	--	602	663-1380
MSP016	Selenium	2.03	1.48	45	--	*54*	21.3-96.9
	Cadmium	5.02	4.17	20.5	--	*41.5*	5.18-54.9
	Chromium	43.3	38.1	164	--	*342*	47.7-320
	Copper	24.3	25.5	27	--	--	27.2-57.3
	Molybdenum	0.653	0.500	5.9	--	--	1.4-5.0
	Nickel	29.6	28.7	86.5	--	*103*	41.4-88.8
	Uranium	3.85	2.37	--	--	--	5.2-90.0
	Vanadium	57.9	49.1	215	--	*507*	59.7-440
	Zinc	180	166	564	--	*975*	171-608
MSP055	Selenium	2.03	1.48	28	--	148	--
	Cadmium	5.02	4.17	67.3	--	104	--
	Chromium	43.3	38.1	467	--	1030	--
	Copper	24.3	25.5	56	--	--	--
	Molybdenum	0.653	0.500	14.8	--	--	--
	Nickel	29.6	28.7	251	--	1110	--
	Uranium	3.85	2.37	--	--	--	--
	Vanadium	57.9	49.1	773	--	940	--
	Zinc	180	166	1600	--	7940	--

Notes:
All concentrations in mg/kg.
--- = Analyte was not sampled during the event.
Orange shaded data exceed background level.
Complete data table is provided in Appendix B, Tables B-4 and B-5.

TABLE 4-7 RIPARIAN SOIL AND SEDIMENT PRELIMINARY COC/COEC CONCENTRATIONS IN SEEPS AND SPRINGS							
Seep/Spring	Analyte	Riparian Soil Bckgrnd, Value	Sediment Bckgrnd, Value	Sampling Event Riparian Soil Spring 2004	Riparian Soil Fall 2010	Sediment Spring 2004	Sediment Fall 2010
MDS016	Selenium	2.03	1.48	7.8	--	9.7	--
	Cadmium	5.02	4.17	16.1	--	12.7	--
	Chromium	43.3	38.1	305	--	137	--
	Copper	24.3	25.5	46	--	--	--
	Molybdenum	0.653	0.500	7.5	--	--	--
	Nickel	29.6	28.7	147	--	123	--
	Uranium	3.85	2.37	--	--	--	--
	Vanadium	57.9	49.1	150	--	103	--
	Zinc	180	166	550	--	371	--
MDS022	Selenium	2.03	1.48	6.9	--	1.9	--
	Cadmium	5.02	4.17	3.04	--	1.82	--
	Chromium	43.3	38.1	24.9	--	10.7	--
	Copper	24.3	25.5	14.3	--	--	--
	Molybdenum	0.653	0.500	1.34	--	--	--
	Nickel	29.6	28.7	62.6	--	34.2	--
	Uranium	3.85	2.37	--	--	--	--
	Vanadium	57.9	49.1	47.7	--	12.7	--
	Zinc	180	166	143	--	76	--
MDS034	Selenium	2.03	1.48	--	--	--	--
	Cadmium	5.02	4.17	--	--	--	--
	Chromium	43.3	38.1	--	--	--	--
	Copper	24.3	25.5	--	--	--	--
	Molybdenum	0.653	0.500	--	--	--	--
	Nickel	29.6	28.7	--	--	--	--
	Uranium	3.85	2.37	--	--	--	--
	Vanadium	57.9	49.1	--	--	--	--
	Zinc	180	166	--	--	--	--
MSG002	Selenium	2.03	1.48	<0.5	--	--	--
	Cadmium	5.02	4.17	0.92	--	--	--
	Chromium	43.3	38.1	29.5	--	--	--
	Copper	24.3	25.5	21.8	--	--	--
	Molybdenum	0.653	0.500	0.56	--	--	--
	Nickel	29.6	28.7	28	--	--	--
	Uranium	3.85	2.37	--	--	--	--
	Vanadium	57.9	49.1	42.7	--	--	--
	Zinc	180	166	73	--	--	--

All concentrations in mg/kg.
--- = Seep/spring or analyte was not sampled during the event.
<#.### = Analyte was not detected at or below the MDL.
Orange shaded data exceed background level.
Complete data table is provided in Appendix B, Tables B-4 and B-5.

TABLE 4-8 FUNCTIONAL USE OF HENRY MINE PONDS			
Pond Name	**Pond ID**	**Tier Classification**	**Selenium Action Level (mg/L)**
Henry Pond	MSP014	1	0.005
Smith Pond	MSP015	2	0.05
Center Henry Pond	MSP016	1	0.005
South Pit Pond	MSP055	3	0.201

Notes:
As reported in the function use survey (IDEQ, 2004b)

TABLE 4-9
SELENIUM, ARSENIC, CADMIUM, NICKEL, AND ZINC CONCENTRATIONS IN SITE PONDS

Pond	Analyte	Sampling Event					
		Spring 04	Spring 06	Spring 07	Spring 08	Fall 08	Fall 10
MSP014	Selenium$^{(T)}$	0.035	*0.0737*	---	---	0.00738	0.0053
	Arsenic	---	*0.00117*	---	---	---	0.00248
	Cadmium	0.0002	*0.00017*	---	---	<0.000125	0.000018
	Nickel	0.0108	*0.0068*	---	---	0.00771	0.0048
	Zinc	0.004	*0.0117*	---	---	<0.005	0.0008
MSP015	Selenium$^{(T)}$	0.153	0.38	---	---	---	0.0225
	Arsenic	---	<0.0005	---	---	---	0.00257
	Cadmium	<0.0001	0.0007	---	---	---	0.000077
	Nickel	0.0035	0.0138	---	---	---	0.0168
	Zinc	0.002	0.04	---	---	---	0.003
MSP016	Selenium$^{(T)}$	*0.124*	0.41	---	---	---	0.0105
	Arsenic	---	<0.0005	---	---	---	0.00253
	Cadmium	*<0.0001*	<0.0001	---	---	---	0.000027
	Nickel	*0.00373*	0.0116	---	---	---	0.0062
	Zinc	*<0.002*	0.014	---	---	---	0.0012
MSP055	Selenium$^{(T)}$	0.97	0.34	0.36	0.53	Dry	---
	Arsenic	---	<0.0013	---	0.0129	Dry	---
	Cadmium	0.0303	0.0203	0.0352	0.0176	Dry	---
	Nickel	0.565	0.434	1.26	0.344	Dry	---
	Zinc	1.9	<0.01	4.73	1.79	Dry	---

Notes:
$^{(T)}$ = Selenium concentrations are total; all other results are dissolved concentrations.
--- = Pond or analyte was not sampled during the event.
<#.### = Analyte was not detected at or below the method detection limit (MDL).
Concentrations in *italics* are triplicate averages.
Blue shaded selenium data exceed applicable FUIs action level.
Orange shaded data exceed comparison screening criteria which are: As = 0.0062 mg/L, Cd = 0.0013, Ni = 0.17, Zn = 0.38 mg/L (aquatic life standards using assumed hardness of 400 mg/L where appropriate). Selenium action level is discussed in preceding text.
Complete data table including validation flags is provided in Appendix B, Table B-6.

TABLE 4-10 SELENIUM, ARSENIC AND CADMIUM CONCENTRATIONS IN SITE SEEPS AND SPRINGS													
Station	Event: Analyte	Spring 2004	Fall 2004	Spring 2006	Spring 2007	Fall 2007	Spring 2008	Fall 2008	Spring 2009	Spring 2010	Fall 2012	Spring 2013	Spring 2014
MDS016	Selenium$^{(T)}$	<0.001	---	0.018	<0.001	Dry	---	Dry	---	---	---	---	---
	Arsenic	---	---	0.0006	---	---	---	---	---	---	---	---	---
	Cadmium	<0.0002	---	0.0008	0.0002	---	---	---	---	---	---	---	---
MDS022	Selenium$^{(T)}$	<0.001	<0.001	0.005	<0.001	<0.001	<0.001	0.0035	---	---	---	---	---
	Arsenic	---	---	<0.0005	---	0.0012	0.001	---	---	---	---	---	---
	Cadmium	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.000125	---	---	---	---	---
MDS034	Selenium$^{(T)}$	---	---	---	---	---	0.14	Dry	0.0505	0.0475	Dry	0.101	0.0164
	Arsenic	---	---	---	---	---	0.0079	---	---	---	---	---	---
	Cadmium	---	---	---	---	---	0.0005	---	0.0001	<0.0003	---	<0.0003	<0.0003
MSG002	Selenium$^{(T)}$	Dry	---	0.001	0.012	Dry	Dry	0.0161	---	---	---	---	---
	Arsenic	---	---	0.0013	---	---	---	---	---	---	---	---	---
	Cadmium	---	---	<0.0001	<0.0001	---	---	<0.000125	---	---	---	---	---

$^{(T)}$ = Selenium concentrations are total, all other results are dissolved concentrations.
--- = Seep/spring or analyte was not sampled during the event.
<#.### = Analyte was not detected at or below the MDL.
Orange shaded data exceed comparison screening criteria.
Comparison screening criteria are – As = 0.0062 mg/L, Cd = 0.0013, Se = 0.0031 mg/L (aquatic life standards using assumed hardness of 400 mg/L where appropriate).
Complete data table is provided in Appendix B, Table B-6.

TABLE 4-11
RISK-BASED PRELIMINARY COCs(1) IN GROUNDWATER THAT DO NOT EXCEED SCREENING CRITERIA

PCOC	Site Range (mg/L)	Background Concentration (2) (mg/L)	Screening Criteria(3) (mg/L)
Arsenic	<0.0025 – 0.0043	0.00103	0.01/0.05
Cobalt	<0.00025 – 0.01	0.000436	NA
Thallium	<0.00005 – 0.0009	0.00020	0.002

Notes:
(1) – COC concentrations presented in the table are total (unfiltered) concentrations in groundwater.
(2) – Background concentrations were provided in Table 2-11 of the *Background Levels Development Technical Memorandum* (MWH, 2013). Level presented at 95% USLs for background samples.
(3) – Regulatory screening levels are Federal MCLs except for arsenic where both the lower Federal MCL and higher State Groundwater Standard are presented.

NA = A drinking water or groundwater standard has not been promulgated.

TABLE 4-12
TOTAL SELENIUM AND CADMIUM CONCENTRATIONS IN SITE BOREHOLES AND MONITORING WELLS

Station	Event: Analyte	Spring 2004	Fall 2004	Spring 2005	Fall 2005	Spring 2006	Fall 2007	Spring 2008	Fall 2008	Spring 2009	Fall 2009	Spring 2010	Fall 2010	Spring* 2012	Spring 2013	Spring 2014
BH030	Selenium	---	---	---	---	---	---	*<0.001*	---	---	---	---	---	---	---	---
BH058	Selenium	---	---	---	---	---	---	*<0.001*	---	---	---	---	---	---	---	---
BH059	Selenium	---	---	---	---	---	---	*0.041*	---	---	---	---	---	---	---	---
BH063	Selenium	---	---	---	---	---	---	*0.13*	---	---	---	---	---	---	---	---
BH073	Selenium	---	---	---	---	---	---	*0.003*	---	---	---	---	---	---	---	---
BH074	Selenium	---	---	---	---	---	---	*0.031*	---	---	---	---	---	---	---	---
BH076	Selenium	---	---	---	---	---	---	*<0.001*	---	---	---	---	---	---	---	---
BH077	Selenium	---	---	---	---	---	---	*<0.001*	---	---	---	---	---	---	---	---
BH075	Selenium	---	---	---	---	---	---	*<0.001*	---	---	---	---	---	---	---	---
BH079	Selenium	---	---	---	---	---	---	*<0.001*	---	---	---	---	---	---	---	---
BH151	Selenium	---	---	---	---	---	---	---	---	*<0.0005*	---	---	---	---	---	---
BH153	Selenium	---	---	---	---	---	---	---	---	*0.0055*	---	---	---	---	---	---
BH157	Selenium	---	---	---	---	---	---	---	---	*0.018*	---	---	---	---	---	---
BH158	Selenium	---	---	---	---	---	---	---	---	*0.0318*	---	---	---	---	---	---
BH167	Selenium	---	---	---	---	---	---	---	---	---	---	---	*0.0183*	---	---	---
BH169	Selenium	---	---	---	---	---	---	---	---	---	---	---	*0.0016*	---	---	---
BH171	Selenium	---	---	---	---	---	---	---	---	---	---	---	*<0.0005*	---	---	---
MBW152	Cadmium	---	---	---	---	---	---	---	---	---	---	<0.0003	---	<0.0006	<0.0003	<0.0003
	Selenium	---	---	---	---	---	---	---	---	*0.0054*	---	0.0021	---	0.0023	0.0021	0.0019
MMW004	Cadmium	*<0.0002*	*<0.0001*	*<0.0001*	<0.1	<0.0001	<0.0001	<0.0001	<0.000125	---	---	---	---	---	---	---
	Selenium	*<0.001*	*<0.001*	*0.0013*	<0.001	0.0013	0.002	0.002	0.0025	0.0027	---	---	---	---	---	---
MMW010	Cadmium	---	---	---	---	---	0.0001	0.0021	0.0053	---	---	0.0045	0.0042	0.00628	0.0045	0.0053
	Selenium	---	---	---	---	---	<0.001	0.1	0.0182	0.0764	0.0191	0.105	0.0213	0.0976	0.219	0.166
MMW011	Cadmium	---	---	---	---	---	0.0007	0.001	0.0004	---	---	0.0006	---	<0.0006	0.0006	0.0007
	Selenium	---	---	---	---	---	<0.001	<0.001	0.0009	0.0021	---	0.0015	---	0.0012	0.001	0.0007
MMW014	Cadmium	---	---	---	---	---	0.0001	0.0001	<0.000125	---	---	---	---	---	---	---
	Selenium	---	---	---	---	---	<0.001	<0.001	0.002	0.0017	---	---	---	---	---	---
MMW019	Cadmium	---	---	---	---	---	<0.0001	<0.0002	<0.000125	---	---	---	---	---	---	---
	Selenium	---	---	---	---	---	<0.001	0.004	0.0006	0.0054	---	---	---	---	---	---
MMW022	Cadmium	---	---	---	---	---	<0.0001	<0.0001	<0.000125	---	---	<0.0003	---	<0.0006	<0.0003	<0.0003
	Selenium	---	---	---	---	---	0.0173	0.017	0.0175	0.0206	---	0.0215	---	0.0410	0.0456	0.0438
MMW023	Cadmium	---	---	---	---	---	0.0007	0.0015	0.0008	---	---	<0.0003	---	<0.0006	<0.0003	<0.0003
	Selenium	---	---	---	---	---	0.003	0.004	0.0039	0.017	---	0.0017	---	0.0026	0.001	<0.0005
MMW028	Cadmium	---	---	---	---	---	---	---	<0.000125	<0.000125	---	<0.0003	---	<0.0006	<0.0003	<0.0003
	Selenium	---	---	---	---	---	---	---	0.0026	0.0055	---	0.0031	---	0.0104	0.0043	0.0033
MPW022	Cadmium	*<0.0002*	---	*<0.0001*	<0.1	<0.0001	<0.0001	<0.0001	<0.000125	---	---	---	---	---	---	---
	Selenium	*0.003*	---	*<0.001*	<0.001	<0.001	<0.001	<0.001	<0.0005	---	---	---	---	---	---	---
MPW023	Cadmium	---	*<0.0001*	*<0.0001*	---	---	<0.0001	<0.0001	<0.000125	---	---	---	---	---	---	---
	Selenium	---	*<0.001*	*<0.001*	---	---	<0.001	<0.001	0.0007	---	---	---	---	---	---	---

Continued on next page

TABLE 4-12
TOTAL SELENIUM AND CADMIUM CONCENTRATIONS IN SITE BOREHOLES AND MONITORING WELLS (continued)

Station	Event: Analyte	Spring 2004	Fall 2004	Spring 2005	Fall 2005	Spring 2006	Fall 2007	Spring 2008	Fall 2008	Spring 2009	Fall 2009	Spring 2010	Fall 2010	Fall* 2012	Spring 2013	Spring 2014
MAW001	Cadmium	<0.0002	---	---	---	---	---	<0.0001	---	---	---	---	---	<0.0006	---	---
	Selenium	<0.001	---	---	---	---	---	0.002	---	---	---	---	---	0.00493	---	---
MAW003	Cadmium	0.0004	---	---	---	---	---	<0.0001	---	---	---	---	---	<0.0006	---	---
	Selenium	<0.001	---	---	---	---	---	0.002	---	---	---	---	---	0.00521	---	---
MAW004	Cadmium	<0.0002	---	---	---	---	---	<0.0001	---	---	---	---	---	---	---	---
	Selenium	<0.001	---	---	---	---	---	<0.001	---	---	---	---	---	---	---	---
MAW006	Cadmium	<0.0002	---	---	---	---	---	0.0002	---	---	---	---	---	<0.0006	---	---
	Selenium	<0.001	---	---	---	---	---	<0.001	---	---	---	---	---	0.00116	---	---
MAW007	Cadmium	<0.0001	---	---	---	---	---	<0.0001	---	---	---	---	---	---	---	---
	Selenium	<0.001	---	---	---	---	---	<0.001	---	---	---	---	---	---	---	---
MDW001	Cadmium	<0.0002	---	---	---	---	---	<0.0001	---	---	---	---	---	<0.0006	---	---
	Selenium	<0.001	---	---	---	---	---	<0.001	---	---	---	---	---	0.0013	---	---
MDW003	Cadmium	<0.0002	---	---	---	---	---	<0.0001	---	---	---	---	---	<0.0006	---	---
	Selenium	0.002	---	---	---	---	---	0.002	---	---	---	---	---	0.0109	---	---
MDW005	Cadmium	<0.0002	---	---	---	---	---	<0.0001	---	---	---	---	---	<0.0006	---	---
	Selenium	<0.001	---	---	---	---	---	0.002	---	---	---	---	---	0.00249	---	---

Notes:
Selenium and cadmium are the only preliminary groundwater COCs to exceed screening critiera.
Concentrations are total for comparison to screening criteria. However, total concentrations are not available for the event, the dissolved concentration is provided in *italics*. Total concentrations were only not available from sampling prior to Fall 2005 and for the direct-push borehole sampling (i.e., the BH locations).
--- = location not sampled during the event.
* = In 2012, monitoring wells were sampled in the spring, the agricultural and domestic wells were sampled in the fall.
<#.### = Analyte was not detected at or below the MDL.
Orange shaded data exceed comparison screening criteria.
Comparison screening criteria are – Cd = 0.005, Se = 0.05 mg/L.
Complete data table is provided in Appendix B, Table B-7.

TABLE 4-13
GROUNDWATER SAMPLING PARAMETERS FOR SPECIATION STUDY

Well ID	Purge Rate (ml/min)	Water Level Drawdown (ft)	DO (mg/L)	ORP (mV)	SC (µS/cm)	Temp. (°C)	pH	Turbidity (NTU)	Fe^{2+} (mg/L)	NO^{2-} (mg/L)
MMW004	150	0.01	5.03	182	745	8.36	6.72	2.0	0.01	0.004
MPW022	200	0.46	0.97	-169	364	7.45	7.39	45	2.35	0.016

TABLE 4-14
GENERAL METALS RESULTS FOR SPECIATION STUDY

Well ID	Total Selenium (mg/L)	Dissolved Selenium (mg/L)	Total Iron (mg/L)	Dissolved Iron (mg/L)	Total Manganese (mg/L)	Dissolved Manganese (mg/L)
MMW004	0.001 U	0.001	0.63	0.02 U	0.40 U	0.0028
MPW022	0.001 U	0.001 U	8.06	4.3	0.50 U	0.233

Notes:
U = Analyte not detected at or below the MDL shown as the result.

TABLE 4-15
SELENIUM SPECIATION AND TOTAL SELENIUM VALUES AND FIELD SPIKE RECOVERIES

Sample ID	Se(IV) (mg/L)	Se(VI) (mg/L)	Sum of Species (mg/L)	Total Se (mg/L)	RPD (%)
103105GWMMW004-1-E	0.00014 U	0.00146	0.00146	0.00132	10.3
103105GWMMW004-1-F	0.00014 U	0.00172	0.00172	0.00209	19.2
103105GWMMW004-2-E	0.00014 U	0.00148	0.00148	0.00135	9.6
103105GWMMW004-2-F	0.00014 U	0.00185	0.00185	0.00174	6.0
103105GWMMW004-3-E	0.00014 U	0.00140	0.00140	0.00157	11.3
103105GWMMW004-3-F	0.00014 U	0.00164	0.00164	0.00170	3.4
103105GWMPW022-0-E	0.00014 U	0.000053 U	0.00014 U	0.00014	200
103105GWMPW022-0-F	0.00014 U	0.000053 U	0.00014 U	0.00014 U	0.0

Notes:
U = Analyte not detected at or below the MDL shown as the result.
Se(CN) was not detected in any sample with a detection limit of approximately 0.001 µg/L
Sample suffix E = non-preserved F = EDTA preserved
EDTA - Ethylenediaminetetraacetic acid

TABLE 4-16
AQUIFER SOLIDS ANALYSES RESULTS

	Location:	MMW010		MMW011	MMW019	MMW022			MMW023
	Date:	28-Aug-07	28-Aug-07	27-Aug-07	10-Aug-07	15-Jul-07	15-Jul-07	15-Jul-07	7-Sep-07
	Unit:	Alluvium		Wells	Phosphoria	Dinwoody			Wells
Parameter	**Units**	**Results**							
Depth	feet	17	38	120	14	5	320	360	350
Location	----	Water	Bottom	Bottom	Bottom	Top	Water	Bottom	Water
pH	s.u.	7.1 J-	7 J-	8 J-	7.4 J-	8.5 J-	8.5 J-	8.43 J-	9.1 J-
Aluminum	mg/kg	9070 J+	29900 J+	4040 J+	14600 J+	4680 J+	10600 J+	11900 J+	649 J+
Cadmium	mg/kg	14.8	0.8 J,B	0.9 J,B	1 J,B	3 U	0.5 U	0.5 U	3.9
Chromium	mg/kg	661	48	20	304	7 J,B	14	15	31
Iron	mg/kg	19100 J	23400 J	4970 J	19600 J	9040	14400	15200	1850 J
Manganese	mg/kg	162	359	27.2	378	4890	2620	2337.5	192
Nickel	mg/kg	278	31	65	96	8 J,B	12	12	26
Selenium	mg/kg	59	0.5 U	0.5 U	7.3	0.8 U,B	0.9 UB	0.8 UB	0.7 J,B
Vanadium	mg/kg	202 J	45.2 J	79.2 J	60.4 J	8.8	15.2	17.2	36.5 J
Zinc	mg/kg	858 J	100 J	509 J	267 J	17 J,B	24	31.8	157 J
TOC	%	2.8 J-	0.2 J-,B	0.1 J-,B	1.7 J-	17	---	---	---
Total Solids	%	86.6	74.5	80.1	85.6	82.4	96.2	93.8	95.8

Notes:
TOC = Total Organic Carbon
J = Estimated
J+ = Estimated, may be biased high
J- = Estimated, may be biased low

U = Not detected at or below the method detection limit
B = Analyte was detected in the blank.

TABLE 4-17 STREAM HABITAT ASSESSMENT DATA MATRIX					
Station	**Surface Water Drainage**	**Surface Water Selenium Concentration (mg/l)**	**Sediment Selenium Concentration (mg/kg)**	**RBS (Habitat Score)**	**Fish Presence**
MST043	Little Blackfoot River	<0.001	1.7	57	Yes
MST044	Little Blackfoot River	<0.001	1.1	143	Yes[1]
MST045	Little Blackfoot River	<0.001	1.1	31	Yes[1]
MST046	Little Blackfoot River	<0.001	0.50	73	Yes[1]
MST047	Little Blackfoot River	<0.001	<0.50	48	Yes[1]
MST048*	Little Blackfoot River	<0.001	0.90	151	Yes
MST049*	Little Blackfoot River	<0.001	<0.50	139	Yes[1]
MST053	Little Blackfoot River	<0.001	<0.50	52	Yes
MST054	Lone Pine Creek	<0.001	2.0	25	No
MST055	Lone Pine Creek	0.002	1.0	43	No
MST057	Lone Pine Creek	0.002	4.4	44	No
MST058	Lone Pine Creek	<0.001	2.0	34	No
MST062	Lone Pine Creek	<0.001	0.30	47	No
MST063	Lone Pine Creek	0.002	0.30	29	No
MST064	Lone Pine Creek	0.002	0.80	55	No
MST234	Little Blackfoot River	<0.001	1.5	76	Yes
MST254*	Little Blackfoot River	<0.001	<0.50	103	Yes
MST276	Lone Pine Creek	0.003	2.0	56	No
MST277*	Long Valley Creek	<0.001	0.80	7	No

Notes:

[1] - no fish observed, but presumed to be present based on hydraulic connection to adjacent stations with fish present; shaded "Yes" highlights those stations where fish were observed

* - Regional background station

TABLE 4-18
RIPARIAN HABITAT ASSESSMENT DATA MATRIX

Station	Surface Water Drainage	Amphibians	Swimming birds	Marsh-nesting birds	Cavity-nesting birds	Birds that forage at water's edge	Aerial-foraging birds	Open cup-nesting birds	Small mammals	Water dependent medium-sized mammals	Upland medium-sized mammals	Game mammals	Livestock	Riparian Soil Selenium Concentration	Vegetation Selenium Concentration	Habitat Quality Ranking
MDS022	Mine Seep	X	X	X	0	0	X	X	X	0	X	X	X	6.9	<0.5	4
MSP014	Mine Pond	X	X	X	X	X	X	X	X	0	X	X	X	12	3.3	1
MSP015	Mine Pond	X	X	0	X	X	0	X	0	0	X	X	X	24	25	3
MSP016	Mine Pond	X	X	0	X	0	0	X	X	0	X	X	X	45	6.5	3
MSP055	Mine Pond	0	0	0	0	X	0	0	0	0	0	0	0	28	65	4
MST044	Little Blackfoot River	0	0	0	X	0	X	X	X	0	X	X	X	5.3	7.9	4
MST045	Little Blackfoot River	X	X	0	X	X	X	0	X	0	X	X	X	1.5	<0.5	3
MST046	Little Blackfoot River	X	X	0	0	0	X	X	0	0	X	0	X	1.1	<0.5	2
MST047	Little Blackfoot River	X	X	0	0	0	X	X	0	0	X	0	X	1.1	<0.5	2
MST049*	Little Blackfoot River	X	X	0	X	0	0	X	X	0	X	X	X	<0.5	<0.5	3
MST054	Lone Pine Creek	X	0	0	0	0	X	0	0	0	0	0	X	1.4	<0.5	2
MST055	Lone Pine Creek	X	0	0	0	0	X	X	0	0	0	0	X	<0.5	<0.5	2
MST057	Lone Pine Creek	X	0	0	X	0	X	X	X	0	X	X	X	3.1	<0.5	4
MST058	Lone Pine Creek	0	0	0	0	0	X	X	X	0	X	X	X	1.3	<0.5	1
MST062	Lone Pine Creek	0	0	0	0	0	X	0	0	0	0	0	X	<0.5	<0.5	2
MST063	Lone Pine Creek	0	0	0	0	0	X	X	X	0	X	X	X	4.3	<0.5	1
MST064	Lone Pine Creek	X	0	X	0	0	X	X	X	0	X	X	X	1.7	<0.5	4
MST275	Lone Pine Creek	X	X	0	X	X	X	X	0	0	X	X	X	<0.5	<0.5	3
MST276	Lone Pine Creek	X	0	X	0	0	X	X	X	0	X	X	X	1.5	<0.5	4
MST277*	Long Valley Creek	X	0	0	0	0	X	X	0	0	0	X	X	0.70	<0.5	2

Notes:
Concentrations in mg/kg dry weight
* - Regional background station
X – presence of species assemblage
0 – lack of species assemblage
6.9 – exceeds riparian soil background level of 2.03 mg/kg or vegetation background level of 0.8 mg/kg dw.

TABLE 4-19
2004 FORAGE FISH CONCENTRATIONS

Sample Location	Cadmium	Nickel	Selenium	Vanadium	Zinc
MRV016	0.10	2.6	2.8	0.49	160
MST043	0.09	3.8	6.1	0.41	180
MST048*	0.15	2.7	3.7	0.70	170
MST053	0.15	8.2	3.5	0.61	230
MST234	<0.10	3.3	3.9	0.43	200
MST254*	<0.24	24	<2.4	0.95	180

Notes:
Concentrations in mg/kg dry weight
All locations are on the Little Blackfoot River or tributary (MST254)
* Regional background location

TABLE 4-20
2004 BENTHIC MACROINVERTEBRATE CONCENTRATIONS

Station ID	Surface Water Drainage	Selenium Concentration
MDS022	Site dump seep	<130
MST043	Little Blackfoot River	<3.2
MST044	Little Blackfoot River	<8.3
MST045	Little Blackfoot River	<6.3
MST046	Little Blackfoot River	<5.5
MST047	Little Blackfoot River	<13
MST048*	Little Blackfoot River	<2.6
MST049*	Little Blackfoot River	3.8
MST053	Little Blackfoot River	<4.2
MST054	Lone Pine Creek	<3.1
MST055	Lone Pine Creek	<4.5
MST057	Lone Pine Creek	6.2
MST058	Lone Pine Creek	<42
MST062	Lone Pine Creek	<1.7
MST063	Lone Pine Creek	<15
MST064	Lone Pine Creek	<3.5
MST234	Little Blackfoot River	<1.8
MST254*	Little Blackfoot River	<1.3
MST275	Lone Pine Creek	<4.2
MST276	Lone Pine Creek	2.9
MST277*	Long Valley Creek	<29

Notes:
Concentration is mg/kg dry weight
* Regional background station

SECTION 6.0 TABLES

Table 6-1
Summary of Constituents of Potential Concern
Henry Site

Analyte	Upland Soil	Riparian Soil	Surface [a] Water	Sediment	Groundwater [b]
Aluminum					
Antimony	X	X		X	
Arsenic	X	X	X	X	X
Barium					
Beryllium					
Boron					
Cadmium	X	X	X	X	
Calcium					
Chromium			X		X
Cobalt	X	X	X	X	X
Copper					
Iron					
Lead					
Magnesium					
Manganese	X	X	X	X	X
Mercury					
Molybdenum					X
Nickel	X	X	X	X	
Potassium					
Radium-226 [c]	X			X	
Radon-222	X				
Selenium	X	X	X	X	X
Silver					
Sodium					
Thallium	X	X	X	X	X
Uranium	X			X	
Vanadium	X	X	X	X	
Zinc				X	

Notes:

[a] Dissolved fraction for all analytes except for selenium, which is expressed as total selenium.

[b] Total fraction for all analytes.

[c] Radium-226 activity data are available for upland soil only; for other media, radium-226 was identified as a constituent of potential concern (COPC) if uranium was identified as a COPC in that medium.

X - constituent of potential concern

Table 6-2
Summary of Tier I Henry Site Cumulative Risk Estimates for Current/Future Native Americans

Medium/Risk Driver[a]	EPC[b]				Current/Future Native American ILCR	Current/Future Native American HI
Metals	**Upland Soil (mg/kg)**	**Riparian Soil (mg/kg)**	**Surface Water (mg/L)**	**Sediment (mg/kg)**		
Culturally Significant Plant - Upland Soil [c]					**2E-04**	**22**
Antimony	9.15	NA	NA	NA	NA	**2.2**
Arsenic	45.5	NA	NA	NA	**1.5E-04**	0.80
Cadmium	59.5	NA	NA	NA	NA	**9.8**
Cobalt	11.9	NA	NA	NA	NA	**3.0**
Selenium	318	NA	NA	NA	NA	**1.9**
Thallium	2.31	NA	NA	NA	NA	**1.7**
Culturally Significant Plant - Riparian Soil					**4E-04**	**57**
Antimony	NA	7.00	NA	NA	NA	**5.8**
Arsenic	NA	4.99	NA	NA	**3.9E-04**	**2.0**
Cadmium	NA	67.3	NA	NA	NA	**5.1**
Cobalt	NA	8.73	NA	NA	NA	**2.8**
Manganese	NA	1,080	NA	NA	NA	**3.1**
Nickel	NA	251	NA	NA	NA	**1.9**
Selenium	NA	45.0	NA	NA	NA	**23**
Thallium	NA	0.223	NA	NA	NA	**1.7**
Vanadium	NA	773	NA	NA	NA	**12**
Elk - Upland Soil and Surface Water					7E-07	0.1
Upland Soil					**9E-05**	**6**
Arsenic	45.5	NA	NA	NA	**8.5E-05**	0.44
Uranium	74.4	NA	NA	NA	NA	**1.2**
Vanadium	584	NA	NA	NA	NA	**2.1**
Riparian Soil					**9E-06**	**4**
Arsenic	NA	4.99	NA	NA	**9.4E-06**	0.049
Vanadium	NA	773	NA	NA	NA	**2.7**
Aquatic Plant - Surface Water and Sediment					**5E-04**	**82**
Antimony	NA	NA	0.00230	8.50	NA	**1.3**
Arsenic	NA	NA	0.0224	10.6	**4.6E-04**	**2.4**
Cadmium	NA	NA	0.0352	104	NA	**14**
Manganese	NA	NA	2.4	2,580	NA	**2.6**
Nickel	NA	NA	1.26	1,110	NA	**1.8**
Selenium	NA	NA	0.970	148	NA	**45**
Thallium	NA	NA	0.000348	2.17	NA	**1.5**
Uranium	NA	NA	NA	90.0	NA	**6.8**
Vanadium	NA	NA	0.0885	940	NA	**1.6**
Zinc	NA	NA	4.73	7,940	NA	**4.2**
Fish - Surface Water and Sediment [d]					**3E-05**	**13**
Antimony	NA	NA	ND	4.70	NA	**6.0**
Arsenic	NA	NA	0.000750	1.99	**2.8E-05**	0.14
Thallium	NA	NA	ND	0.122	NA	**6.2**
Surface Water					**4E-06**	0.7
Arsenic	NA	NA	0.0224	NA	**4.2E-06**	0.022
Radionuclides - Radium-226	**Upland Soil (pCi/g)**	**Riparian Soil (pCi/g)**	**Surface Water (pCi/L)**	**Sediment (pCi/g)**		
Culturally Significant Plants - Upland Soil	58.8	NA	NA	NA	**2.4E-03**	NA
Elk - Upland Soil	58.8	NA	NA	NA	1.0E-06	NA
Upland Soil	58.8	NA	NA	NA	**9.4E-04**	NA

Table 6-2
Summary of Tier I Henry Site Cumulative Risk Estimates for Current/Future Native Americans

Medium/Risk Driver[a]	EPC[b]				Current/Future Native American ILCR	Current/Future Native American HI
Aquatic Plant - Sediment	NA	NA	NA	62.6	**1.3E-03**	NA
Fish - Surface Water	NA	NA	0.720	NA	4.2E-07	NA
Cumulative Media ILCR/HI from Metals[e]:					**6E-04**	**101**
Cumulative Media ILCR from Radionuclides[f]:					**3E-03**	NA
Cumulative Media ILCR/HI from Metals and Radionuclides[e,f]:					**4E-03**	**101**
IDEQ Point of Departure:					10^{-5}	1
USEPA Risk Range:					10^{-6} - 10^{-4}	1

Notes:

[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented for risk drivers only. Risk estimates for all COPCs are presented in Appendix A.

[b] The EPC is based on the maximum detected concentration measured in various media collected from Henry Site sampling locations.

[c] Hazard estimates for antimony and thallium in culturally significant plants harvested from upland soil are based on the maximum detection limit for these analytes, as they were not detected in culturally significant plant tissue.

[d] The surface water and sediment EPCs for the fish consumption pathway is based on data from sample locations where fish are present or likely to be present.

[e] Cumulative media ILCR/HI for metals includes the higher of the ILCR/HI for culturally significant plants harvested from upland soil, riparian soil, or aquatic environments, and the higher of the ILCR/HI for upland soil or riparian soil direct contact.

[f] Cumulative media ILCR for radium-226 includes the higher of the ILCR for culturally significant plants harvested from upland soil or aquatic environments.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/L - milligram per liter
mg/kg - milligram per kilogram
NA - Not applicable
pCi/g - picoCuries per gram
pCi/L - picoCuries per liter

Table 6-3
Summary of Tier I Background Cumulative Risk Estimates for Current/Future Native Americans

Medium/Risk Driver[a]	EPC[b]				Current/Future Native American ILCR	Current/Future Native American HI
Metals	**Upland Soil (mg/kg)**	**Riparian Soil (mg/kg)**	**Surface Water (mg/L)**	**Sediment (mg/kg)**		
Culturally Significant Plant - Upland Soil [c]					**1E-03**	**77**
Antimony	3.60	NA	NA	NA	NA	**38**
Arsenic	19.0	NA	NA	NA	**1.5E-03**	**7.8**
Cadmium	44.0	NA	NA	NA	NA	**3.5**
Cobalt	13.3	NA	NA	NA	NA	**4.3**
Manganese	3,990	NA	NA	NA	NA	**11**
Nickel	230	NA	NA	NA	NA	**1.7**
Selenium	29.0	NA	NA	NA	NA	**1.1**
Thallium	1.30	NA	NA	NA	NA	**2.1**
Uranium	42.0	NA	NA	NA	NA	**1.4**
Vanadium	370	NA	NA	NA	NA	**5.7**
Culturally Significant Plant - Riparian Soil					**4E-04**	**19**
Antimony	NA	5.50	NA	NA	NA	**4.5**
Arsenic	NA	5.44	NA	NA	**4.3E-04**	**2.2**
Cadmium	NA	4.40	NA	NA	NA	**1.6**
Cobalt	NA	10.1	NA	NA	NA	**3.2**
Manganese	NA	1,080	NA	NA	NA	**3.1**
Thallium	NA	0.428	NA	NA	NA	**3.2**
Elk - Upland Soil and Surface Water					2E-07	0.04
Upland Soil					**4E-05**	**3**
Arsenic	19.0	NA	NA	NA	**3.6E-05**	0.18
Vanadium	370	NA	NA	NA	NA	**1.3**
Riparian Soil					**1E-05**	0.7
Arsenic	NA	5.44	NA	NA	**1.0E-05**	0.053
Aquatic Plant - Surface Water and Sediment					**2E-04**	**6**
Arsenic	NA	NA	0.00110	4.55	**2.0E-04**	1.0
Cadmium	NA	NA	0.000100	3.74	NA	**2.3**
Fish - Surface Water and Sediment					**4E-05**	**83**
Antimony	NA	NA	NA	5.00	NA	**6.4**
Arsenic	NA	NA	0.00110	4.55	**4E-05**	0.21
Thallium	NA	NA	0.000150	0.378	NA	**76**
Surface Water					2E-07	0.02
Radionuclides - Radium-226	**Upland Soil (pCi/g)**	**Riparian Soil (pCi/g)**	**Surface Water (pCi/L)**	**Sediment (pCi/g)**		
Culturally Significant Plants - Upland Soil	27.2	NA	NA	NA	**1.1E-03**	NA
Elk - Upland Soil	27.2	NA	NA	NA	4.8E-07	NA
Upland Soil	27.2	NA	NA	NA	**4.4E-04**	NA
Aquatic Plant - Sediment	NA	NA	NA	1.65	**3.5E-05**	NA
Fish - Surface Water	NA	NA	0.417	NA	2.4E-07	NA
Cumulative Media ILCR/HI from Metals[d]:					**2E-03**	**163**
Cumulative Media ILCR from Radionuclides[e]:					**2E-03**	NA
Cumulative Media ILCR/HI from Metals and Radionuclides[d,e]:					**3E-03**	**163**
IDEQ Point of Departure:					10^{-5}	1
USEPA Risk Range:					10^{-6} - 10^{-4}	1

Notes:

[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented for risk drivers only. Risk estimates for all COPCs are presented in Appendix A.

Table 6-3 Summary of Tier I Background Cumulative Risk Estimates for Current/Future Native Americans			
		Current/Future Native American	
Medium/Risk Driver[a]	EPC[b]	ILCR	HI

[b] The EPC is based on the maximum detected concentration measured in various media collected from background sampling locations.

[c] The hazard estimate for antimony in culturally significant plants harvested from upland soil is based on the maximum detection limit for antimony, as it was not detected in culturally significant plant tissue samples.

[d] Cumulative media ILCR/HI for metals includes the higher of the ILCR/HI for culturally significant plants harvested from upland soil, riparian soil, or aquatic environments, and the higher of the ILCR/HI for upland soil or riparian soil direct contact.

[e] Cumulative media ILCR for radium-226 includes the higher of the ILCR for culturally significant plants harvested from upland soil or aquatic environments.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/L - milligram per liter
mg/kg - milligram per kilogram
NA - Not applicable
pCi/g - picoCuries per gram
pCi/L - picoCuries per liter
USEPA - U. S. Environmental Protection Agency

Table 6-4
Summary of Tier I Henry Site Cumulative Risk Estimates for Hypothetical Future Residents

Medium/Risk Driver[a]	EPC[b]					Hypothetical Future Resident ILCR	Hypothetical Future Resident HI
Metals	**Upland Soil (mg/kg)**	**Riparian Soil (mg/kg)**	**Surface Water (mg/L)**	**Sediment (mg/kg)**	**Groundwater (mg/L)**		
Fruits and Vegetables - Upland Soil and Groundwater						**1E-02**	**319**
Antimony	9.15	NA	NA	NA	NA	NA	**2.3**
Arsenic	45.5	NA	NA	NA	0.00430	**1.2E-02**	**60**
Cadmium	59.5	NA	NA	NA	NA	NA	**9.4**
Cobalt	11.9	NA	NA	NA	0.0100	NA	**2.5**
Manganese	2,040	NA	NA	NA	3.39	NA	**1.5**
Molybdenum	NA	NA	NA	NA	0.110	NA	**45**
Nickel	425	NA	NA	NA	NA	NA	**1.5**
Selenium	318	NA	NA	NA	0.219	NA	**53**
Thallium	2.31	NA	NA	NA	0.000900	NA	**128**
Uranium	74.4	NA	NA	NA	NA	NA	**11**
Vanadium	584	NA	NA	NA	NA	NA	**4.6**
Upland Soil						**9E-05**	**6**
Arsenic	45.5	NA	NA	NA	NA	**8.5E-05**	0.44
Uranium	74.4	NA	NA	NA	NA	NA	**1.2**
Vanadium	584	NA	NA	NA	NA	NA	**2.1**
Riparian Soil						8E-07	0.3
Fish - Surface Water and Sediment [c]						**3E-05**	**13**
Antimony	NA	NA	ND	4.70	NA	NA	**6.0**
Arsenic	NA	NA	0.000750	1.99	NA	**2.8E-05**	0.14
Thallium	NA	NA	ND	0.122	NA	NA	**6.2**
Surface Water						6E-07	0.1
Groundwater						**1E-04**	**10**
Arsenic	NA	NA	NA	NA	0.00430	**1.1E-04**	0.59
Cobalt	NA	NA	NA	NA	0.0100	NA	**1.4**
Manganese	NA	NA	NA	NA	3.39	NA	**1.1**
Selenium	NA	NA	NA	NA	0.219	NA	**1.8**
Thallium	NA	NA	NA	NA	0.000900	NA	**3.7**
Radionuclides - Radium-226	**Upland Soil (pCi/g)**	**Riparian Soil (pCi/g)**	**Surface Water (pCi/L)**	**Sediment (pCi/g)**	**Groundwater (pCi/L)**		
Fruits and Vegetables - Upland Soil	58.8	NA	NA	NA	NA	**2.4E-03**	NA
Upland Soil	58.8	NA	NA	NA	NA	**9.4E-04**	NA
Fish - Surface Water	NA	NA	0.720	NA	NA	4.2E-07	NA
Radionuclides - Radom-222 [d]	**Upland Soil (pCi/m^3)**						
Indoor Air	13,327					**5.5E-02**	NA
Cumulative Media ILCR/HI for Metals[e]:						**1E-02**	**348**
Cumulative Media ILCR for Radionuclides:						**6E-02**	NA
Cumulative Media ILCR/HI from Metals and Radionuclides[e]:						**7E-02**	**348**
IDEQ Point of Departure:						10^{-5}	1
USEPA Risk Range:						10^{-6} - 10^{-4}	1

Notes:

[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented for risk drivers only. Risk estimates for all COPCs are presented in Appendix A.

[b] The EPC is based on the maximum detected concentration measured in various media collected from Henry Site sampling locations.

[c] The surface water and sediment EPCs for the fish consumption pathway is based on data from sample locations where fish are present or likely to be present.

Table 6-4 Summary of Tier I Henry Site Cumulative Risk Estimates for Hypothetical Future Residents			
		Hypothetical Future Resident	
Medium/Risk Driver[a]	EPC[b]	ILCR	HI

[d] The radon-222 concentration in indoor air was calculated from radon flux measurements made in background upland soil, and is in units of picoCuries per cubic meter (pCi/m^3).

[e] Cumulative media ILCR/HI for metals includes the higher of the ILCR/HI for upland soil or riparian soil direct contact.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/L - milligram per liter
mg/kg - milligram per kilogram
NA - Not applicable
USEPA - U. S. Environmental Protection Agency
pCi/g - picoCuries per gram
pCi/L - picoCuries per liter
pCi/m^3 - picoCuries per cubic meter

Table 6-5
Summary of Tier I Background Cumulative Risk Estimates for Hypothetical Future Residents

Medium/Risk Driver[a]	EPC[b]					Hypothetical Future Resident ILCR	Hypothetical Future Resident HI
Metals	**Upland Soil (mg/kg)**	**Riparian Soil (mg/kg)**	**Surface Water (mg/L)**	**Sediment (mg/kg)**	**Groundwater (mg/L)**		
Fruits and Vegetables - Upland Soil and Groundwater						**2E-03**	**70**
Antimony	3.60	NA	NA	NA	NA	NA	**24**
Arsenic	19.0	NA	NA	NA	0.000989	**1.5E-03**	**7.8**
Cadmium	44.0	NA	NA	NA	NA	NA	**2.8**
Cobalt	13.3	NA	NA	NA	0.000436	NA	**4.3**
Manganese	3,990	NA	NA	NA	0.456	NA	**11**
Molybdenum	NA	NA	NA	NA	0.0239	NA	**3.3**
Nickel	230	NA	NA	NA	NA	NA	**1.7**
Selenium	29.0	NA	NA	NA	0.00267	NA	**2.6**
Thallium	1.30	NA	NA	NA	0.000200	NA	**5.0**
Vanadium	370	NA	NA	NA	NA	NA	**5.7**
Upland Soil						**4E-05**	**3**
Arsenic	19.0	NA	NA	NA	NA	**3.6E-05**	0.18
Vanadium	370	NA	NA	NA	NA	NA	**1.3**
Riparian Soil						8E-07	0.06
Fish - Surface Water and Sediment						**4E-05**	**83**
Antimony	NA	NA	NA	5.00	NA	NA	**6.4**
Arsenic	NA	NA	0.00110	4.55	NA	**4E-05**	0.21
Thallium	NA	NA	0.000150	0.378	NA	NA	**76**
Surface Water						3E-08	0.003
Groundwater						**3E-05**	1
Arsenic	NA	NA	NA	NA	0.000989	**2.6E-05**	0.14
Radionuclides - Radium-226	**Upland Soil (pCi/g)**	**Riparian Soil (pCi/g)**	**Surface Water (pCi/L)**	**Sediment (pCi/g)**	**Groundwater (pCi/L)**		
Fruits and Vegetables - Upland Soil	27.2	NA	NA	NA	NA	**1.1E-03**	NA
Upland Soil	27.2	NA	NA	NA	NA	**4.4E-04**	NA
Fish - Surface Water	NA	NA	0.417	NA	NA	2.4E-07	NA
Radionuclides - Radom-222 [c]	**Indoor Air (pCi/m^3)**						
Indoor Air	12,684					**5.2E-02**	NA
Cumulative Media ILCR/HI from Metals[d]:						**2E-03**	**157**
Cumulative Media ILCR from Radionuclides:						**5E-02**	NA
Cumulative Media ILCR/HI from Metals and Radionuclides[d]:						**6E-02**	**157**
IDEQ Point of Departure:						10^{-5}	1
USEPA Risk Range:						10^{-6} - 10^{-4}	1

Notes:

[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented if the COPC is a risk driver only. Risk estimates for all COPCs are presented in Appendix A.

[b] The EPC is based on the maximum detected concentration measured in various media collected from background sampling locations.

[c] The radon-222 concentration in indoor air was calculated from radon flux measurements made in background upland soil, and is in units of picoCuries per cubic meter (pCi/m^3).

[d] Cumulative media ILCR/HI for metals includes the higher of the ILCR/HI for upland soil or riparian soil direct contact.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/L - milligram per liter
mg/kg - milligram per kilogram
NA - Not applicable
pCi/g - picoCuries per gram
pCi/L - picoCuries per liter
pCi/m^3 - picoCuries per cubic meter
USEPA - U. S. Environmental Protection Agency

Table 6-6
Summary of Tier I Henry Site Cumulative Risk Estimates for Current/Future Seasonal Ranchers

Medium/Risk Driver[a]	**EPC[b]**			**Current/Future Seasonal Rancher**	
				ILCR	**HI**
Metals	**Upland Soil (mg/kg)**	**Surface Water (mg/L)**	**Groundwater (mg/L)**		
Cattle - Upland Soil and Surface Water				**9E-05**	**15**
Arsenic	45.5	0.0224	NA	**9.4E-05**	0.61
Cobalt	11.9	0.0141	NA	NA	**1.4**
Selenium	318	0.970	NA	NA	**2.4**
Thallium	2.31	0.000348	NA	NA	**9.1**
Cattle - Upland Soil and Groundwater				**9E-05**	**15**
Arsenic	45.5	NA	0.00430	**8.8E-05**	0.57
Cobalt	11.9	NA	0.0100	NA	**1.3**
Selenium	318	NA	0.219	NA	**1.6**
Thallium	2.31	NA	0.000900	NA	**9.9**
Upland Soil				**1E-05**	1
Arsenic	45.5	NA	NA	**1.5E-05**	0.094
Groundwater				**2E-05**	0.1
Arsenic	NA	NA	0.00430	**2.1E-05**	0.0065
Radionuclides - Radium-226	**Upland Soil (pCi/g)**	**Surface Water (pCi/L)**	**Groundwater (pCi/L)**		
Cattle - Upland Soil	58.8	NA	NA	**9.3E-05**	NA
Upland Soil	58.8	NA	NA	**1.9E-03**	NA
Cumulative Media ILCR/HI from Metals[c]:				**1E-04**	**16**
Cumulative Media ILCR from Radionuclides:				**2E-03**	NA
Cumulative Media ILCR/HI from Metals and Radionuclides[c]:				**2E-03**	**16**
IDEQ Point of Departure:				10^{-5}	1
USEPA Risk Range:				10^{-6} - 10^{-4}	1

Notes:

[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented for risk drivers only. Risk estimates for all COPCs are presented in Appendix A.

[b] The EPC is based on the maximum detected concentration measured in various media collected from Henry Site sampling locations.

[c] Cumulative media ILCR/HI for metals includes the higher of the ILCR/HI for consumption of cattle that have ingested surface water or groundwater. Surface water and ground water ingestion by cattle were not evaluated for radium-226 because uranium, and therefore radium-226, was not identified as a chemical of potential concern for these media.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/L - milligram per liter
mg/kg - milligram per kilogram
NA - Not applicable
USEPA - U. S. Environmental Protection Agency
pCi/g - picoCuries per gram
pCi/L - picoCuries per liter

Table 6-7
Summary of Tier I Background Cumulative Risk Estimates for Current/Future Seasonal Ranchers

Medium/Risk Driver[a]	EPC[b]			Current/Future Seasonal Rancher ILCR	Current/Future Seasonal Rancher HI
Metals	**Upland Soil (mg/kg)**	**Surface Water (mg/L)**	**Groundwater (mg/L)**		
Cattle - Upland Soil and Surface Water				**4E-05**	**8**
Arsenic	19.0	0.00110	NA	**3.6E-05**	0.24
Cobalt	13.3	0.0100	NA	NA	**1.4**
Thallium	1.30	0.000150	NA	NA	**5.1**
Cattle - Upland Soil and Groundwater				**4E-05**	**8**
Arsenic	19.0	NA	0.000989	**3.6E-05**	0.24
Cobalt	13.3	NA	0.000436	NA	**1.2**
Thallium	1.30	NA	0.000200	NA	**5.1**
Upland Soil				**6E-06**	0.8
Arsenic	19.0	NA	NA	**6.1E-06**	0.039
Groundwater				**5E-06**	0.02
Arsenic	NA	NA	0.000989	**4.8E-06**	0.0015
Radionuclides - Radium-226	**Upland Soil (pCi/g)**	**Surface Water (pCi/L)**	**Groundwater (pCi/L)**		
Cattle - Upland Soil	27.2	NA	NA	**4.3E-05**	NA
Upland Soil	27.2	NA	NA	**9.0E-04**	NA
Cumulative Media ILCR/HI from Metals[c]:				**5E-05**	**9**
Cumulative Media ILCR from Radionuclides:				**9E-04**	NA
Cumulative Media ILCR/HI from Metals and Radionuclides[c]:				**1E-03**	**9**
IDEQ Point of Departure:				10^{-5}	1
USEPA Risk Range:				10^{-6} - 10^{-4}	1

Notes:

[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented for risk drivers only. Risk estimates for all COPCs are presented in Appendix A.

[b] The EPC is based on the maximum detected concentration measured in various media collected from background sampling locations.

[c] Cumulative media ILCR/HI for metals includes the higher of the ILCR/HI for consumption of cattle that have ingested surface water or groundwater. Surface water and ground water ingestion by cattle were not evaluated for radium-226 because uranium, and therefore radium-226, was not identified as a chemical of potential concern for these media.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/kg - milligram per kilogram
mg/L - milligram per liter
NA - Not applicable
USEPA - U. S. Environmental Protection Agency
pCi/g - picoCuries per gram
pCi/L - picoCuries per liter

Table 6-8
Summary of Refined Human Health Constituent of Potential Concern to be Evaluated in Tier II Baseline Risk Assessment
Henry Site

COPCs	**Direct Exposure**				**Indirect Exposure** [a]							
	Upland Soil	Riparian Soil	Surface Water	Ground-water	Upland Culturally Significant Plant	Riparian Culturally Significant Plant	Aquatic Culturally Significant Plant	Fruits and Vegetables	Elk	Cattle - Surface Water	Cattle - Ground-water	Fish
Antimony	X	X			**X**	**X**	**X**	**X**	X	X	X	X
Arsenic	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	X	**X**	**X**	**X**
Cadmium	X	X	X		**X**	**X**	X	**X**	X	X	X	**X**
Chromium			X	X				X	X	X	X	X
Cobalt	X	X	X	**X**	**X**	**X**	X	**X**	X	**X**	**X**	X
Manganese	X	X	X	**X**	X	**X**	**X**	**X**	X	X	X	X
Molybdenum				X				**X**			X	
Nickel	X	X	X		X	**X**	**X**	**X**	X	X	X	**X**
Radium-226	**X**				**X**		**X**	**X**	X	**X**	**X**	**X**
Radon-222 [b]	**X**											
Selenium	X	X	X	**X**	**X**	**X**	**X**	**X**	X	**X**	**X**	**X**
Thallium	X	X	X	**X**	**X**	**X**	**X**	**X**	X	**X**	**X**	**X**
Uranium	**X**				X		**X**	**X**	X	X	X	X
Vanadium	**X**	**X**	X		X	**X**	**X**	**X**	X	X	X	X
Zinc							**X**					**X**

Notes:
[a] All media-specific COPCs were evaluated for the indirect pathways indicated in Figure 6-1 in addition to direct exposure pathways (i.e., ingestion, inhalation, and dermal contact) except sediment COPCs, which were evaluated through the indirect uptake to aquatic culturally significant plant pathway only.
[b] Radon-222 was evaluated for indoor air exposure only; receptors are not directly exposed to radon-222 in upland soil.
[c] COPCs further evaluated in the Tier II Baseline Risk Assessment are those with a chemical-specific ILCR or HQ exceeding 1 x 10^{-6} or 1, respectively, in the Tier I Baseline Risk Assessment.

X - constituent of potential concern
X - Tier I constituent of potential concern [c]

COPC - constituent of potential concern
ILCR - incremental lifetime cancer risk
HQ - hazard quotient

Table 6-9
Summary of Tier II RME Henry Site Cumulative Incremental Risk Estimates for Current/Future Native Americans

Medium/Risk Driver[a]	EPC[b]				Current/Future Native American					
					Site-Related		Background		Incremental	
					ILCR	HI	ILCR	HI	ILCR	HI
Metals	**Upland Soil (mg/kg)**	**Riparian Soil (mg/kg)**	**Surface Water (mg/L)**	**Sediment (mg/kg)**						
Culturally Significant Plant - Upland Soil [c]					**2E-04**	**18**	**6E-04**	**56**	0E+00	**2**
Antimony	4.81	NA	NA	NA	NA	**2.2**	NA	**38**	NA	0
Arsenic	24.9	NA	NA	NA	**1.5E-04**	0.80	**6.5E-04**	**3.3**	0E+00	0
Cadmium	32.5	NA	NA	NA	NA	**9.0**	NA	**9.8**	NA	0
Cobalt	7.74	NA	NA	NA	NA	**3.0**	NA	**2.5**	NA	0.42
Selenium	46.4	NA	NA	NA	NA	**1.3**	NA	0.17	NA	**1.2**
Thallium	1.31	NA	NA	NA	NA	**1.7**	NA	**2.1**	NA	0
Culturally Significant Plant - Riparian Soil					**3E-04**	**21**	**3E-04**	**15**	0E+00	**7**
Antimony	NA	6.17	NA	NA	NA	**5.1**	NA	**4.5**	NA	0.55
Arsenic	NA	4.25	NA	NA	**3.3E-04**	**1.7**	**3.5E-04**	**1.8**	0E+00	0
Cadmium	NA	7.38	NA	NA	NA	**1.2**	NA	0.98	NA	0.25
Cobalt	NA	7.98	NA	NA	NA	**2.6**	NA	**2.7**	NA	0
Manganese	NA	901	NA	NA	NA	**2.5**	NA	**1.8**	NA	0.70
Selenium	NA	14.9	NA	NA	NA	**3.1**	NA	0.28	NA	**2.8**
Thallium	NA	0.200	NA	NA	NA	**1.5**	NA	**2.5**	NA	0
Vanadium	NA	165	NA	NA	NA	**2.6**	NA	0.57	NA	**2.0**
Elk - Upland Soil and Surface Water					NA	NA	NA	NA	NA	NA
Upland Soil					**5E-05**	**2**	**2E-05**	0.6	**3E-05**	1.1
Arsenic	24.9	NA	NA	NA	**4.7E-05**	0.24	**1.5E-05**	0.080	**3.1E-05**	0.16
Riparian Soil					**8E-06**	0.6	**8E-06**	0.2	0E+00	0.4
Arsenic	NA	4.25	NA	NA	**8.0E-06**	0.041	**8.3E-06**	0.043	0E+00	0
Aquatic Plant - Surface Water and Sediment					**3E-04**	**30**	**2E-04**	**5**	**1E-04**	**24**
Arsenic	NA	NA	0.00928	7.49	**3.2E-04**	**1.7**	**2.0E-04**	1.0	**1.3E-04**	0.65
Cadmium	NA	NA	0.00371	27.1	NA	**6.7**	NA	**1.7**	NA	**5.0**
Manganese	NA	NA	1.17	1,130	NA	**1.1**	NA	0.41	NA	0.73
Selenium	NA	NA	0.102	49.8	NA	**14**	NA	0.18	NA	**13**
Uranium	NA	NA	0.00586	30.6	NA	**2.3**	NA	0.18	NA	**2.1**
Zinc	NA	NA	0.484	1,385	NA	**1.6**	NA	0.38	NA	**1.2**
Fish - Surface Water and Sediment [d]					**3E-05**	**12**	**3E-05**	**83**	6E-07	0.003
Antimony	NA	NA	ND	4.70	NA	**6.0**	NA	**6.4**	NA	0
Arsenic	NA	NA	0.000750	1.99	**2.8E-05**	0.14	**2.7E-05**	0.14	5.6E-07	0.0029
Thallium	NA	NA	ND	0.122	NA	**6.2**	NA	**76**	NA	0

Table 6-9
Summary of Tier II RME Henry Site Cumulative Incremental Risk Estimates for Current/Future Native Americans

Medium/Risk Driver[a]	EPC[b]				Current/Future Native American					
					Site-Related		Background		Incremental	
					ILCR	HI	ILCR	HI	ILCR	HI
Surface Water					**2E-06**	0.009	1E-07	0.0007	**2E-06**	0.008
Arsenic	NA	NA	0.008942	NA	**1.7E-06**	0.0089	1.4E-07	0.00071	**1.6E-06**	0.0082
Radionuclides - Radium-226	**Upland Soil (pCi/g)**	**Riparian Soil (pCi/g)**	**Surface Water (pCi/L)**	**Sediment (pCi/g)**						
Culturally Significant Plant - Upland Soil	12.6	NA	NA	NA	**5.1E-04**	NA	**1.9E-04**	NA	**3.1E-04**	NA
Elk - Upland Soil	12.6	NA	NA	NA	NA	NA	NA	NA	NA	NA
Upland Soil	12.6	NA	NA	NA	**2.0E-04**	NA	**7.7E-05**	NA	**1.2E-04**	NA
Aquatic Plant - Sediment	NA	NA	NA	21.3	**4.5E-04**	NA	**3.5E-05**	NA	**4.1E-04**	NA
Fish - Surface Water	NA	NA	0.578	NA	NA	NA	NA	NA	NA	NA
Cumulative Media ILCR/HI from Metals[e]:					**4E-04**	**44**	**7E-04**	**139**	**2E-04**	**26**
Cumulative Media ILCR from Radionuclides[f]:					**7E-04**	NA	**3E-04**	NA	**4E-04**	NA
Cumulative Media ILCR/HI from Metals and Radionuclides[e,f]:					**1E-03**	**44**	**1E-03**	**139**	**6E-04**	**26**
IDEQ Point of Departure:					10^{-5}	1				
USEPA Risk Range:					10^{-6} - 10^{-4}	1				

Notes:

[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented if the COPC is a Site-related risk driver. Risk estimates for all COPCs are presented in Appendix A.

[b] The EPC is based on either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit (UCL) or the maximum detected concentration measured in various media collected from Henry Site sampling locations.

[c] Hazard estimates for antimony and thallium in culturally significant plants harvested from upland soil at the Henry Site are based on the maximum detection limit for these analytes, as they were not detected in Site culturally significant plant tissue. The hazard estimate for antimony in culturally significant plants harvested from upland soil at background locations is based on the maximum detection limit, as antimony was not detected in background culturally significant plant tissue.

[d] The surface water and sediment EPCs for the fish consumption pathway is based on data from sample locations where fish are present or likely to be present.

[e] Cumulative media ILCR/HI for metals includes the higher of the ILCR/HI for culturally significant plants harvested from upland soil, riparian soil, or aquatic environments, and the higher of the ILCR/HI for upland soil or riparian soil direct contact.

[f] Cumulative media ILCR for radium-226 includes the higher of the ILCR for culturally significant plants harvested from upland soil or aquatic environments.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/kg - milligram per kilogram
mg/L - milligram per liter
NA - Not applicable
RME - reasonable maximum exposure
pCi/g - picoCuries per gram
pCi/L - picoCuries per liter
UCL - upper confidence limit
USEPA - U. S. Environmental Protection Agency

Table 6-10
Summary of Tier II RME Henry Site Cumulative Incremental Risk Estimates for Hypothetical Future Residents

Medium/Risk Driver[a]	**EPC[b]**					**Hypothetical Future Resident**					
						Site-Related		**Background**		**Incremental**	
						ILCR	**HI**	**ILCR**	**HI**	**ILCR**	**HI**
Metals	**Upland Soil (mg/kg)**	**Riparian Soil (mg/kg)**	**Surface Water (mg/L)**	**Sediment (mg/kg)**	**Groundwater (mg/L)**						
Fruits and Vegetables - Upland Soil and Groundwater						**2E-03**	**78**	**7E-04**	**42**	**1E-03**	**64**
Antimony	4.81	NA	NA	NA	NA	NA	**2.3**	NA	**24**	NA	0
Arsenic	24.9	NA	NA	NA	0.00227	**2.0E-03**	**10**	**6.6E-04**	**3.4**	**1.3E-03**	**6.7**
Cadmium	32.5	NA	NA	NA	NA	NA	**2.8**	NA	0.73	NA	**2.1**
Cobalt	7.74	NA	NA	NA	0.0100	NA	**1.5**	NA	**2.6**	NA	0
Molybdenum	NA	NA	NA	NA	0.0373	NA	**7.6**	NA	**1.1**	NA	**6.5**
Selenium	46.4	NA	NA	NA	0.0479	NA	**6.2**	NA	0.33	NA	**5.9**
Thallium	1.31	NA	NA	NA	0.000505	NA	**45**	NA	**2.5**	NA	**43**
Uranium	40.5	NA	NA	NA	NA	NA	**1.3**	NA	0.96	NA	0.32
Upland Soil						**5E-05**	**2**	**2E-05**	0.6	**3E-05**	1
Arsenic	24.9	NA	NA	NA	NA	**4.7E-05**	0.24	**1.5E-05**	0.080	**3.1E-05**	0.16
Riparian Soil						NA	NA	NA	NA	NA	NA
Fish - Surface Water and Sediment [c]						**3E-05**	**12**	**3E-05**	**83**	6E-07	0.003
Antimony	NA	NA	ND	4.70	NA	NA	**6.0**	NA	**6.4**	NA	0
Arsenic	NA	NA	0.000750	1.99	NA	**2.8E-05**	0.14	**2.7E-05**	0.14	5.6E-07	0.0029
Thallium	NA	NA	ND	0.122	NA	NA	**6.2**	NA	**76**	NA	0
Surface Water						NA	NA	NA	NA	NA	NA
Groundwater						**6E-05**	**4**	**2E-05**	1	**4E-05**	**3**
Arsenic	NA	NA	NA	NA	0.00227	**6.0E-05**	0.31	**1.9E-05**	0.10	**4.1E-05**	0.21
Cobalt	NA	NA	NA	NA	0.0100	NA	**1.4**	NA	0.060	NA	**1.3**
Thallium	NA	NA	NA	NA	0.000505	NA	**2.1**	NA	0.83	NA	**1.3**
Radionuclides - Radium-226	**Upland Soil (pCi/g)**	**Riparian Soil (pCi/g)**	**Surface Water (pCi/L)**	**Sediment (pCi/g)**	**Groundwater (pCi/L)**						
Fruits and Vegetables - Upland Soil	12.6	NA	NA	NA	NA	**5.1E-04**	NA	**1.9E-04**	NA	**3.1E-04**	NA
Upland Soil	12.6	NA	NA	NA	NA	**2.0E-04**	NA	**7.7E-05**	NA	**1.2E-04**	NA
Fish - Surface Water	NA	NA	0.578	NA	NA	NA	NA	NA	NA	NA	NA
Radionuclides - Radom-222 [d]	**Indoor Air (pCi/m^3)**										
Indoor Air	8,084					**3.3E-02**	NA	**1.6E-02**	NA	**1.8E-02**	NA

Table 6-10
Summary of Tier II RME Henry Site Cumulative Incremental Risk Estimates for Hypothetical Future Residents

Medium/Risk Driver[a]	EPC[b]	Hypothetical Future Resident					
		Site-Related		Background		Incremental	
		ILCR	HI	ILCR	HI	ILCR	HI
Cumulative Media ILCR/HI from Metals[e]:		**2E-03**	**97**	**7E-04**	**126**	**1E-03**	**69**
Cumulative Media ILCR from Radionuclides:		**3E-02**	NA	**2E-02**	NA	**2E-02**	NA
Cumulative Media ILCR/HI from Metals and Radionuclides[e]:		**4E-02**	**97**	**2E-02**	**126**	**2E-02**	**69**
IDEQ Point of Departure:		10^{-5}	1				
USEPA Risk Range:		10^{-6} - 10^{-4}	1				

Notes:

[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented if the COPC is a Site-related risk driver. Risk estimates for all COPCs are presented in Appendix A.
[b] The EPC is based on either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit (UCL) or the maximum detected concentration measured in various media collected from Henry Site sampling locations.
[c] The surface water and sediment EPCs for the fish consumption pathway is based on data from sample locations where fish are present or likely to be present.
[d] The radon-222 concentration in indoor air was calculated from radon flux measurements made in background upland soil, and is in units of picoCuries per cubic meter (pCi/m_3).
[e] Cumulative media ILCR/HI for metals includes the higher of the ILCR/HI for upland soil or riparian soil direct contact.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/kg - milligram per kilogram
mg/L - milligram per liter
NA - not applicable
RME - reasonable maximum exposure
pCi/g - picoCuries per gram
pCi/L - picoCuries per liter
pCi/m^3 - picoCuries per cubic meter
UCL - upper confidence limit
USEPA - U. S. Environmental Protection Agency

Table 6-11
Summary of Tier II RME Henry Site Cumulative Incremental Risk Estimates for Current / Future Seasonal Ranchers

Medium/Risk Driver[a]	EPC[b]			Current/Future Seasonal Rancher					
				Henry Site		Background		Incremental	
				ILCR	HI	ILCR	HI	ILCR	HI
Metals	**Upland Soil (mg/kg)**	**Surface Water (mg/L)**	**Groundwater (mg/L)**						
Cattle - Upland Soil and Surface Water				**5E-05**	**6**	**2E-05**	**3**	**3E-05**	**3**
Arsenic	24.9	0.00928	NA	**5.0E-05**	0.33	**1.6E-05**	0.10	**3.5E-05**	0.22
Thallium	1.31	0.0000813	NA	NA	**5.0**	NA	**2.1**	NA	**2.9**
Cattle - Upland Soil and Groundwater				**5E-05**	**7**	**2E-05**	**3**	**3E-05**	**4**
Arsenic	24.9	NA	0.00227	**4.8E-05**	0.31	**1.6E-05**	0.10	**3.2E-05**	0.21
Thallium	1.31	NA	0.000505	NA	**5.6**	NA	**2.2**	NA	**3.4**
Upland Soil				**8E-06**	0.4	**3E-06**	0.1	**5E-06**	0.2
Arsenic	24.9	NA	NA	**8.0E-06**	0.052	**2.6E-06**	0.017	**5.3E-06**	0.035
Groundwater				**1E-05**	0.05	**4E-06**	0.01	**8E-06**	0.04
Arsenic	NA	NA	0.00227	**1.1E-05**	0.0034	**3.5E-06**	0.0011	**7.5E-06**	0.0024
Radionuclides - Radium-226	**Upland Soil (pCi/g)**	**Surface Water (pCi/L)**	**Groundwater (pCi/L)**						
Cattle - Upland Soil	12.6	NA	NA	**2.0E-05**	NA	**7.6E-06**	NA	**1.2E-05**	NA
Upland Soil	12.6	NA	NA	**4.2E-04**	NA	**1.6E-04**	NA	**2.6E-04**	NA
Cumulative Media ILCR/HI from Metals[d]:				**7E-05**	**7**	**2E-05**	**3**	**5E-05**	**4**
Cumulative Media ILCR from Radionuclides[d]:				**4E-04**	NA	**2E-04**	NA	**3E-04**	NA
Cumulative Media ILCR/HI from Metals and Radionuclies[d]:				**5E-04**	**7**	**2E-04**	**3**	**3E-04**	**4**
IDEQ Point of Departure:				10^{-5}	1				
USEPA Risk Range:				10^{-6} - 10^{-4}	1				

Notes:

[a] Summary of risk estimates for constituents of potencial concern (COPCs) are presented if the COPC is a Henry Site risk driver. Risk estimates for all COPCs are presented in Appendix A.

[b] The EPC is based on either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit (UCL) or the maximum detected concentration measured in various media collected from Henry Site sampling locations.

[c] Cumulative media ILCR/HI for metals includes the higher of the ILCR/HI for consumption of cattle that have ingested surface water or groundwater. Surface water and ground water ingestion by cattle were not evaluated for radium-226 because uranium, and therefore radium-226, was not identified as a chemical of potential concern for these media.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

EPC - Exposure Point Concentration	mg/kg - milligram per kilogram	pCi/L - picoCuries per liter
HI - Hazard Index	mg/L - milligram per liter	RME - reasonable maximum exposure
IDEQ - Idaho Department of Environmental Quality	NA - Not applicable	UCL - upper confidence limit
ILCR - Incremental lifetime cancer risk	pCi/g - picoCuries per gram	USEPA - U. S. Environmental Protection Agency

Table 6-12
Summary of Tier II RME Henry Site Cumulative Incremental Risk Estimates for Current / Future Recreational Hunters

Medium/Risk Driver[a]	EPC[b]		Current/Future Recreational Hunter					
			Henry Site		Background		Incremental	
			ILCR	HI	ILCR	HI	ILCR	HI
Metals	**Upland Soil (mg/kg)**	**Surface Water (mg/L)**						
Elk - Upland Soil and Surface Water			NA	NA	NA	NA	NA	NA
Upland Soil			8E-07	0.04	3E-07	0.01	5E-07	0.02
Radionuclides - Radium-226	**Upland Soil (pCi/g)**	**Surface Water (pCi/L)**						
Elk - Upland Soil	12.6	NA	NA	NA	NA	NA	NA	NA
Upland Soil	12.6	NA	**9.7E-05**	NA	**3.7E-05**	NA	**6.0E-05**	NA
Cumulative Media ILCR/HI for Metals:			8E-07	0.04	3E-07	0.01	5E-07	0.02
Cumulative Media ILCR for Radionuclides:			**1E-04**	NA	**4E-05**	NA	**6E-05**	NA
Cumulative Media ILCR/HI from Metals and Radionuclides:			**1E-04**	0.04	**4E-05**	0.01	**6E-05**	0.02
IDEQ Point of Departure:			10^{-5}	1				
USEPA Risk Range:			10^{-6} - 10^{-4}	1				

Notes:

[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented if the COPC is a Henry Site risk driver. Risk estimates for all COPCs are presented in Appendix A.

[b] The EPC is based on either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit (UCL) or the maximum detected concentration measured in various media collected from Henry Site sampling locations.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/kg - milligram per kilogram
mg/L - milligram per liter
NA - Not applicable
RME - reasonable maximum exposure
UCL - upper confidence limit
USEPA - U. S. Environmental Protection Agency

Table 6-13
Summary of Tier II RME Henry Site Cumulative Incremental Risk Estimates for Current / Future Recreational Camper / Hikers

Medium/Risk Driver[a]	EPC[b]	Current/Future Recreational Camper/Hiker					
		Henry Site		Background		Incremental	
		ILCR	HI	ILCR	HI	ILCR	HI
Metals	**Upland Soil (mg/kg)**						
Upland Soil		1E-06	0.04	4E-07	0.01	8E-07	0.03
Radionuclides - Radium-226	**Upland Soil (pCi/g)**						
Upland Soil	12.6	**6.0E-05**	NA	**2.3E-05**	NA	**3.7E-05**	NA
Cumulative Media ILCR/HI from Metals:		1E-06	0.04	4E-07	0.01	8E-07	0.03
Cumulative Media ILCR from Radionuclides:		**6E-05**	NA	**2E-05**	NA	**4E-05**	NA
Cumulative Media ILCR/HI from Metals and Radionuclides:		**6E-05**	0.04	**2E-05**	0.01	**4E-05**	0.03
IDEQ Point of Departure:		10^{-5}	1	10^{-5}	1	10^{-5}	1
USEPA Risk Range:		10^{-6} - 10^{-4}	1	10^{-6} - 10^{-4}	1	10^{-6} - 10^{-4}	1

Notes:

[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented if the COPC is a Henry Site risk driver. Risk estimates for all COPCs are presented in Appendix A.

[b] The EPC is based on either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit (UCL) or the maximum detected concentration measured in various media collected from Henry Site sampling locations.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/kg - milligram per kilogram
RME - reasonable maximum exposure
pCi/g - picoCuries per gram
UCL - upper confidence limit
USEPA - U. S. Environmental Protection Agency

Table 6-14
Summary of Tier II RME Henry Site Cumulative Incremental Risk Estimates for Current / Future Recreational Fishers

Medium/Risk Driver[a]	EPC[b]			Current/Future Recreational Fisher					
				Site-Related		Background		Incremental	
				ILCR	HI	ILCR	HI	ILCR	HI
Metals	**Riparian Soil (mg/kg)**	**Surface Water (mg/L)**	**Sediment (mg/kg)**						
Riparian Soil				NA	NA	NA	NA	NA	NA
Fish - Surface Water and Sediment [c]				**3E-05**	**12**	**3E-05**	**83**	6E-07	0.003
Antimony	NA	ND	4.70	NA	**6.0**	NA	**6.4**	NA	0
Arsenic	NA	0.000750	1.99	**2.8E-05**	0.14	**2.7E-05**	0.14	5.6E-07	0.0029
Thallium	NA	ND	0.122	NA	**6.2**	NA	**76**	NA	0
Surface Water				NA	NA	NA	NA	NA	NA
Cumulative Media ILCR/HI from Metals[d]:				**3E-05**	**12**	**3E-05**	**83**	6E-07	0.003
IDEQ Point of Departure:				10^{-5}	1				
USEPA Risk Range:				10^{-6} - 10^{-4}	1				

Notes:

[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented if the COPC is a Site-related risk driver. Risk estimates for all COPCs are presented in Appendix A.

[b] The EPC is based on either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit (UCL) or the maximum detected concentration measured in various media collected from Henry Site sampling locations.

[c] The surface water and sediment EPCs for the fish consumption pathway is based on data from sample locations where fish are present or likely to be present.

[d] Cumulative Media ILCR is calculated based on exposure to metals only, as risks associated with exposure to radium-226 was de minimus in the Tier II risk assessment and therefore not carried in to the Tier II risk assessment.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/kg - milligram per kilogram
mg/L - milligram per liter
NA - Not applicable
RME - reasonable maximum exposure
pCi/g - picoCuries per gram
pCi/L - picoCuries per liter
UCL - upper confidence limit
USEPA - U. S. Environmental Protection Agency

Table 6-15
Summary of Constituents of Potential Ecological Concern
Henry Site

Analyte	Upland Soil	Riparian Soil	Surface Water [a]	Sediment
Aluminum			X	
Antimony	X	X		X
Arsenic	X			X
Barium			X	
Beryllium				
Boron	X	X	X	X
Cadmium	X	X	X	X
Calcium				
Chromium	X	X		X
Cobalt			X	
Copper	X	X		X
Iron				
Lead				
Magnesium				
Manganese	X [b]	X [b]	X	X
Mercury	X	X		X
Molybdenum	X	X		X
Nickel	X	X	X	X
Potassium				
Selenium	X	X	X	X
Silver	X			X
Sodium				
Thallium	X	X		X
Uranium	X	X	X	X
Vanadium	X	X	X	X
Zinc	X	X	X	X

Notes:

[a] Dissolved fraction for all analytes except for selenium, which is expressed as total selenium.

[b] Ecological hazard for avian and mammalian receptors was not evaluated for this constituent in soil because this chemical was not identifed as an avian and mammal constituent of potential ecological concern. Avian and mammalian ecological hazards associated with surface water exposures to this constituent were estimated.

X - constituent of potential ecological concern

Table 6-16
Ecological Hazard Calculations for Amphibians and Fish
Henry Site

Constituent	Surface Water EPC[a] (mg/L)	National Standards Aquatic Life [b] (mg/L)	Tier II Secondary Chronic Value [c] (mg/L)	Final Water Quality Criteria [d]	Ecological HQ
Aluminum	0.905	0.087	--	0.087	**10**
Barium	0.0810	--	0.0040	0.0040	**20**
Boron	0.121	--	0.0016	0.0016	**76**
Cadmium	0.0352	0.00047 [e]	--	0.00047	**75**
Cobalt	0.0141	--	0.023	0.023	0.61
Manganese	2.44	--	0.12	0.12	**20**
Nickel	1.26	0.12 [e]	--	0.12	**11**
Selenium	0.970	0.0031 [f]	--	0.0031	**313**
Uranium	0.0206	--	0.0026	0.0026	**7.9**
Vanadium	0.0885	--	0.02	0.020	**4.4**
Zinc	4.73	0.26 [e]	--	0.26	**18**

Notes:

[a] The surface water exposure point concentrations are equal to the maximum detected concentration measured in samples collected from upstream and downstream surface water stations

[b] National Recommended Water Quality Criteria (USEPA, 2013b); Freshwater Criterion Continuous Concentration (CCC) listed for all analytes except for silver. Only a Criterion Maximum Concentration (CMC) is available for silver.

[c] Tier II Secondary Chronic Value. Source: ORNL, 1996a.

[d] The final water quality criteria were obtained from the following hierarchy: 1) National Recommended Water Quality Criteria (USEPA, 2013b) and 2) Tier II Secondary Chronic Value

[e] The freshwater criterion for this metal is expressed as a function of hardness in the water column. The value given here corresponds to a hardness of 256 mg calcium carbonate per L water, which is the lowest average hardness for Henry Site streams and ponds. Criteria values for other hardness may be calculated from the following: CMC (dissolved) = exp {mA[ln(hardness)]+bA} (CF), or CCC (dissolved) = exp {mC[ln(hardness)]+bC} (CF) and the parameters specified in Appendix B of National Recommended Water Quality Criteria (USEPA, 2015b).

[f] New criteria developed in 2016 are 0.0015 mg/L for lentic systems, and 0.0031 mg/L for lotic systems. Although aquatic habitat at the Henry Site is generally lotic, and therefore the applicable final water quality criterion presented here is 0.0031 mg/L.

"- -" - not available
EPC - exposure point concentration
HQ - hazard quotient
mg/L - milligrams per liter

Table 6-17
Summary of Tier I Henry Site Hazard Estimates for Ecological Receptors

	EPC [a]				Ecological Hazard Estimates (HQ)										
	Upland Soil (mg/kg)	Riparian Soil (mg/kg)	Surface Water (mg/L)	Sediment (mg/kg)	Long-Tailed Vole[b]	Elk[b]	American Goldfinch[b]	Deer Mouse[b]	Raccoon[b]	American Robin[b]	Mallard	Mink	Coyote[b]	Great Blue Heron	Northern Harrier
					NOAEL-Based Ecological Hazard Estimates										
Aluminum	NA	NA	0.905	NA	0.065	0.0016	0.0019	0.069	**9.6**	0.0011	**7.1**	**329**	0.0051	0.0056	0.00063
Antimony	9.15	7.00	0.00230	8.50	**3.9**	0.0059	na	**13**	0.57	na	na	**12**	0.68	na	na
Arsenic	45.5	NA	0.0224	10.6	**3.4**	0.0053	**1.8**	**1.6**	0.0039	0.65	0.056	**1.9**	0.074	0.27	0.027
Barium	NA	NA	0.0810	NA	0.00022	0.0000054	0.00091	0.00023	0.0022	0.00052	0.19	0.79	0.000017	0.58	0.00030
Boron	39.0	5.90	0.121	17.4	0.53	0.00087	0.47	0.31	0.0081	0.21	0.050	0.092	0.065	0.0038	0.15
Cadmium	59.5	67.3	0.0352	104	**2.8**	0.0045	**2.1**	**22**	0.88	**11**	0.81	**37**	0.46	**6.4**	0.49
Chromium	519	467	0.00760	1,030	**3.9**	0.0059	**7.2**	**6.7**	0.43	**7.3**	1.0	**12**	0.75	0.66	**1.2**
Cobalt	NA	NA	0.0141	10.6	0.00026	0.0000067	0.00043	0.00028	0.00022	0.00025	0.0061	0.0055	0.000021	0.00017	0.00014
Copper	172	56.0	0.00379	68.8	**1.1**	0.0017	**2.2**	**1.6**	0.043	**2.4**	0.39	**1.8**	0.18	0.24	0.50
Manganese	NA	NA	2.4	2,580	0.007	0.0002	0.003	0.007	0.003	0.002	0.12	0.06	0.0005	0.008	0.0010
Mercury	0.503	0.0240	ND	0.236	0.025	0.000039	0.071	0.045	0.0013	0.098	0.016	0.019	0.0052	0.015	0.026
Molybdenum	35.7	14.8	0.0400	10.8	**149**	0.24	**9.7**	**69**	0.86	**2.9**	0.12	**21**	**6.6**	0.068	**1.1**
Nickel	425	251	1.26	1,110	**5.1**	0.010	**2.5**	**21**	0.60	**5.6**	0.30	**52**	0.89	**3.8**	0.41
Selenium	318	45.0	0.970	148	**333**	0.55	**164**	**166**	**5.1**	**60**	**16**	**679**	**5.9**	**101**	**3.7**
Silver	7.30	NA	ND	2.16	0.017	0.000026	0.12	0.19	0.00066	0.58	0.077	0.075	0.0040	0.050	0.020
Thallium	2.31	0.223	0.000348	2.17	**64**	0.10	0.73	**73**	**1.3**	0.69	0.23	**722**	**4.5**	**2.4**	0.099
Uranium	74.4	1.66	0.0206	90.0	0.31	0.00047	0.15	**2.0**	0.027	0.40	0.20	1.0	**1.1**	0.0042	0.51
Vanadium	584	773	0.0885	940	**2.0**	0.0030	**57**	**1.4**	0.25	**30**	**8.3**	**9.4**	0.26	**2.2**	**3.7**
Zinc	1,610	1,600	4.73	7,940	**1.1**	0.0020	**1.6**	**1.4**	0.17	**1.6**	0.52	**98**	0.12	**35**	0.27
Ecological Hazard Criterion:					1	1	1	1	1	1	1	1	1	1	1

Notes:

[a] The abiotic media exposure point concentrations used in the Tier I Ecological Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at the Henry Site.

[b] Ecological dose and HQ estimates for terrestrial and riparian herbivorous and omnivorous species preferentially used the maximum detected COPEC concentration measured in upland and riparian vegetation from Henry Site sampling locations, where available, over plant tissue concentrations modeled from abiotic media.

Bold indicates exceedance of IDEQ's and USEPA's acceptable ecological hazard criterion

COPEC - constituent of potential ecological concern
EPC - exposure point concentration
HQ - Hazard quotient
IDEQ - Idaho Department of Environmental Quality
mg/kg - milligrams per kilogram
mg/L - milligrams per liter
NA - not applicable
na - not available
ND - not detected
NOAEL - no observed adverse effects level
USEPA - U. S. Environmental Protection Agency

Table 6-18
Summary of Tier I Background Hazard Estimates for Ecological Receptors

	EPC [a]				Ecological Hazard Estimates (HQ)										
	Upland Soil (mg/kg)	Riparian Soil (mg/kg)	Surface Water (mg/L)	Sediment (mg/kg)	Long-Tailed Vole[b]	Elk[b]	American Goldfinch[b]	Deer Mouse[b]	Raccoon[b]	American Robin[b]	Mallard	Mink	Coyote[b]	Great Blue Heron	Northern Harrier
					NOAEL-Based Ecological Hazard Estimates										
Aluminum	NA	NA	0.410	NA	0.029	0.00074	0.00087	0.031	**4.4**	0.00050	**3.2**	**149**	0.0023	0.0025	0.00029
Antimony	3.60	5.50	NA	5.00	**29**	0.046	na	**16**	0.43	na	na	**21**	0.34	na	na
Arsenic	19.0	NA	0.00110	4.55	0.35	0.00052	0.32	0.29	0.0014	0.19	0.028	0.13	0.029	0.014	0.012
Barium	NA	NA	0.0850	NA	0.00023	0.0000057	0.00095	0.00024	0.0023	0.00055	0.20	0.83	0.000018	0.60	0.00031
Boron	25.0	11.2	0.0200	8.40	0.76	0.0012	0.65	0.36	0.014	0.21	0.024	0.15	0.043	0.0062	0.095
Cadmium	44.0	4.40	0.000100	3.74	**1.2**	0.0018	**1.2**	**17**	0.099	**8.7**	0.078	0.67	0.36	0.16	0.39
Chromium	420	42.5	0.00393	34.8	**3.5**	0.0053	**6.0**	**5.6**	0.042	**6.0**	0.10	**1.4**	0.62	0.061	1.0
Copper	82.0	21.1	ND	25.5	0.72	0.0011	**1.3**	0.86	0.025	**1.2**	0.29	**1.6**	0.14	0.34	0.42
Manganese	NA	NA	0.0484	405	0.00013	0.0000033	0.000063	0.00014	0.00047	0.000036	0.028	0.015	0.000010	0.0010	0.000021
Mercury	0.320	0.0690	NA	0.0380	0.029	0.000046	0.071	0.045	0.0017	0.091	0.0074	0.011	0.0035	0.0081	0.017
Molybdenum	29.0	0.700	ND	ND	**11**	0.018	0.90	**13**	0.088	0.85	NA	0.94	**5.1**	0.0031	0.90
Nickel	230	26.6	0.00221	24.4	**2.2**	0.0032	**1.2**	**11**	0.065	**3.0**	0.047	**1.6**	0.54	0.043	0.26
Selenium	29.0	1.80	0.00100	1.60	**17**	0.027	**9.4**	**13**	0.095	**5.5**	0.39	**3.2**	**1.1**	0.17	1.0
Silver	2.40	NA	ND	0.241	0.034	0.000053	0.11	0.075	0.000074	0.21	0.0086	0.0083	0.0014	0.0056	0.0067
Thallium	1.30	0.428	0.000150	0.378	**4.7**	0.0069	0.12	**29**	0.74	0.32	0.039	**314**	**2.5**	1.0	0.056
Uranium	42.0	3.76	0.00120	2.37	0.12	0.00016	0.075	**1.1**	0.0063	0.22	0.0053	0.45	0.62	0.0037	0.29
Vanadium	370	57.3	0.00620	45.2	0.79	0.0011	**31**	0.68	0.018	**18**	0.40	0.69	0.16	0.13	**2.3**
Zinc	1,200	158	0.0150	151	**1.1**	0.0018	**1.5**	**1.3**	0.028	**1.4**	0.11	0.92	0.11	0.18	0.25
Ecological Hazard Criterion:					1	1	1	1	1	1	1	1	1	1	1

Notes:

[a] The abiotic media exposure point concentrations used in the Tier I Background Ecological Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at background locations.

[b] Ecological dose and HQ estimates for terrestrial and riparian herbivorous and omnivorous species preferentially used the maximum detected COPEC concentration measured in upland and riparian vegetation from background sampling locations, where available, over plant tissue concentrations modeled from abiotic media.

Bold indicates exceedance of IDEQ's and USEPA's acceptable ecological hazard criterion

COPEC - constituent of potential ecological concern
EPC - exposure point concentration
HQ - Hazard quotient
IDEQ - Idaho Department of Environmental Quality
mg/kg - milligrams per kilogram
mg/L - milligrams per liter
NA - not applicable
na - not available
ND - not detected
NOAEL - no observed adverse effects level
USEPA - U. S. Environmental Protection Agency

Table 6-19
Summary of Tier II Henry Site Hazard Estimates for Ecological Receptors

	EPC [a]				Ecological Hazard Estimates (HQ)									
	Upland Soil (mg/kg)	**Riparian Soil (mg/kg)**	**Surface Water (mg/L)**	**Sediment (mg/kg)**	**Long-Tailed Vole[b]**	**American Goldfinch[b]**	**Deer Mouse[b]**	**Raccoon[b]**	**American Robin[b]**	**Mallard**	**Mink**	**Coyote[b]**	**Great Blue Heron**	**Northern Harrier**
					NOAEL-Based Ecological Hazard Estimates									
Aluminum	NA	NA	0.165	NA	0.012	0.00035	0.013	**1.8**	0.00020	**1.3**	**60**	0.00093	0.0010	0.00012
Antimony	4.81	6.17	0.000657	6.03	**3.3**	na	**7.5**	0.48	na	na	**9.6**	0.36	na	na
Arsenic	24.9	NA	0.00928	7.49	0.65	0.49	0.45	0.0025	0.27	0.042	0.82	0.038	0.11	0.016
Cadmium	32.5	7.38	0.00371	27.1	1.0	0.92	**13**	0.15	**6.8**	0.31	**4.4**	0.29	0.76	0.32
Chromium	271	123	0.00159	217	**1.3**	**3.1**	**3.2**	0.12	**3.7**	0.31	**3.5**	0.43	0.17	0.71
Copper	124	22.0	0.00263	41.5	0.55	**1.3**	**1.1**	0.024	**1.6**	0.33	**1.3**	0.16	0.16	0.46
Molybdenum	16.8	4.64	0.0111	4.29	**24**	**1.6**	**14**	0.19	0.74	0.047	**6.7**	**3.0**	0.021	0.53
Nickel	212	70.4	0.138	199	**1.8**	**1.1**	**10**	0.17	**2.7**	0.072	**7.7**	0.51	0.48	0.24
Selenium	46.4	14.9	0.102	49.8	**38**	**19**	**23**	0.88	**9.3**	**6.1**	**80**	**1.5**	**11**	**1.3**
Thallium	1.31	0.200	0.0000813	1.12	**23**	0.29	**36**	0.58	0.36	0.12	**176**	**2.5**	0.55	0.056
Uranium	40.5	1.43	0.00586	30.6	0.11	0.072	1.0	0.011	0.22	0.069	0.45	0.60	0.0023	0.28
Vanadium	212	165	0.00989	231	0.47	**18**	0.40	0.053	**10**	**2.0**	**2.0**	0.093	0.50	**1.3**
Zinc	890	397	0.484	1,385	0.32	0.60	0.93	0.047	**1.1**	0.23	**11**	0.097	**3.6**	0.24
Ecological Hazard Criterion:					1	1	1	1	1	1	1	1	1	1

Notes:

[a] The abiotic media exposure point concentrations used in the Tier II Ecological Risk Assessment are equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration measured in samples collected from the Henry Site.

[b] Ecological dose and HQ estimates for terrestrial and riparian herbivorous and omnivorous species preferentially used either the maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean detected COPEC concentration measured in upland and riparian vegetation from Henry Site sampling locations, where available, over plant tissue concentrations modeled from abiotic media.

Bold indicates exceedance of IDEQ's and USEPA's acceptable ecological hazard criterion

COPEC - constituent of potential ecological concern
EPC - exposure point concentration
HQ - Hazard quotient
IDEQ - Idaho Department of Environmental Quality
mg/kg - milligrams per kilogram
mg/L - milligrams per liter
NA - not applicable
na - not available
ND - not detected
NOAEL - no observed adverse effects level
USEPA - U. S. Environmental Protection Agency

Table 6-20
Summary of Tier II Background Hazard Estimates for Ecological Receptors

	EPC[a]				Ecological Hazard Estimates (HQ)									
	Upland Soil (mg/kg)	Riparian Soil (mg/kg)	Surface Water (mg/L)	Sediment (mg/kg)	Long-Tailed Vole[b]	American Goldfinch[b]	Deer Mouse[b]	Raccoon[b]	American Robin[b]	Mallard	Mink	Coyote[b]	Great Blue Heron	Northern Harrier
					NOAEL-Based Ecological Hazard Estimates									
Aluminum	NA	NA	0.0990	NA	0.0071	0.00021	0.0075	**1.1**	0.00012	0.78	**36**	0.00056	0.00061	0.000069
Antimony	1.04	5.50	NA	5.00	**28**	na	**12**	0.43	na	na	**21**	0.16	na	na
Arsenic	8.20	NA	0.000735	4.55	0.15	0.14	0.14	0.0013	0.091	0.028	0.10	0.013	0.0096	0.0059
Cadmium	13.6	2.81	0.000100	2.29	0.32	0.34	**6.6**	0.068	**3.4**	0.056	0.51	0.15	0.12	0.18
Chromium	108	27.9	0.000775	26.3	0.90	**1.6**	**1.4**	0.028	**1.5**	0.089	0.93	0.20	0.038	0.35
Copper	27.0	18.5	NA	25.5	0.43	0.65	0.36	0.023	0.44	0.29	**1.6**	0.10	0.34	0.34
Molybdenum	7.94	0.508	NA	NA	**2.7**	0.22	**3.4**	0.061	0.23	NA	0.68	**1.4**	0.0023	0.25
Nickel	69.8	20.2	0.00129	19.7	0.78	0.39	**3.4**	0.052	0.91	0.050	**1.3**	0.23	0.032	0.12
Selenium	6.67	1.12	0.000579	1.01	**1.8**	**1.2**	**2.7**	0.079	**1.4**	0.27	**2.4**	0.49	0.11	0.54
Thallium	0.510	0.333	0.000150	0.378	**2.0**	0.049	**11**	0.65	0.13	0.039	**312**	0.97	1.0	0.022
Uranium	10.2	2.91	0.000529	2.37	0.041	0.020	0.27	0.0050	0.055	0.0053	0.35	0.15	0.0029	0.069
Vanadium	93.3	37.0	0.00140	33.0	0.20	**7.8**	0.17	0.012	**4.5**	0.29	0.44	0.041	0.088	0.59
Zinc	473	117	0.00525	107	0.65	0.78	0.90	0.025	0.92	0.10	0.68	0.086	0.10	0.22
Ecological Hazard Criterion:					1	1	1	1	1	1	1	1	1	1

Notes:

[a] The abiotic media exposure point concentrations used in the Tier II Background Ecological Risk Assessment are equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the lower of the maximum detected concentration measured in samples collected from Background locations.

[b] Ecological dose and HQ estimates for terrestrial and riparian herbivorous and omnivorous species preferentially used either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean detected COPEC concentration or the maximum detected concentration measured in upland and riparian vegetation from background sampling locations, where available, over plant tissue concentrations modeled from abiotic media.

Bold indicates exceedance of IDEQ's and USEPA's acceptable ecological hazard criterion

COPEC - constituent of potential ecological concern
EPC - exposure point concentration
HQ - Hazard quotient
IDEQ - Idaho Department of Environmental Quality
mg/kg - milligrams per kilogram
mg/L - milligrams per liter
NA - not applicable
na - not available
ND - not detected
NOAEL - no observed adverse effects level
USEPA - U. S. Environmental Protection Agency

Table 6-21
Summary of Livestock Constituents of Potential Concern
Henry Site

Analyte	Upland Soil	Surface Water [a]
Aluminum		X
Antimony	X	
Arsenic	X	
Barium		X
Beryllium		
Boron	X	X
Cadmium	X	X
Calcium		
Chromium	X	
Cobalt		X
Copper	X	
Iron		
Lead		
Magnesium		
Manganese	X [b]	X
Mercury	X	
Molybdenum	X	
Nickel	X	X
Potassium		
Selenium	X	X
Silver	X	
Sodium		
Thallium	X	
Uranium	X	X
Vanadium	X	X
Zinc	X	X

Notes:
[a] Dissolved fraction for all analytes except for selenium, which is expressed as total selenium.
[b] Livestock hazard was not evaluated for this constituent in soil because this chemical was not identifed as a mammalian constituent of potential ecological concern. Livestock hazards associated with surface water exposures to this constituent were estimated.

X - livestock constituent of potential concern

Table 6-22
Summary of Tier I Henry Site Hazard Estimates for Livestock

	EPC [a]		Livestock Hazard Estimates (HQ)
	Upland Soil (mg/kg)	Surface Water (mg/L)	Beef Cattle[b]
			NOAEL-Based Livestock Hazard Estimates
Aluminum	NA	0.905	0.0082
Antimony	9.15	0.00230	0.090
Arsenic	45.5	0.0224	0.081
Barium	NA	0.0810	0.000027
Boron	39.0	0.121	0.013
Cadmium	59.5	0.0352	0.067
Chromium	519	0.00760	0.090
Cobalt	NA	0.0141	0.000034
Copper	172	0.00379	0.026
Manganese	NA	2.4	0.0008
Mercury	0.503	ND	0.00059
Molybdenum	35.7	0.0400	**3.7**
Nickel	425	1.26	0.13
Selenium	318	0.970	**8.2**
Silver	7.30	ND	0.00039
Thallium	2.31	0.000348	**1.6**
Uranium	74.4	0.0206	0.0069
Vanadium	584	0.0885	0.046
Zinc	1,610	4.73	0.028
		Hazard Criterion:	1

Notes:

[a] The abiotic media exposure point concentrations used in the Tier I Henry Site Livestock Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at Henry Site locations.

[b] Dose and HQ estimates for beef cattle preferentially used the maximum detected LCOPC concentration measured in upland vegetation from background sampling locations, where available, over plant tissue concentrations modeled from abiotic media.

Bold indicates exceedance of IDEQ's and USEPA's acceptable hazard criterion

NA - not applicable
ND - not detected
EPC - exposure point concentration
HQ - Hazard quotient
IDEQ - Idaho Department of Environmental Quality
LCOPC - livestock constituent of potential concern
mg/kg - milligrams per kilogram
mg/L - milligrams per liter
NOAEL - no observed adverse effects level
USEPA - U. S. Environmental Protection Agency

Table 6-23
Summary of Tier I Background Hazard Estimates for Livestock

	EPC [a]		Livestock Hazard Estimates (HQ)
	Upland Soil (mg/kg)	**Surface Water (mg/L)**	**Beef Cattle[b]**
			NOAEL-Based Livestock Hazard Estimates
Aluminum	NA	0.410	0.0037
Antimony	3.60	NA	0.70
Arsenic	19.0	0.00110	0.0080
Barium	NA	0.0850	0.000029
Boron	25.0	0.0200	0.019
Cadmium	44.0	0.000100	0.028
Chromium	420	0.00393	0.081
Copper	82.0	ND	0.017
Manganese	NA	0.0484	0.000016
Mercury	0.320	NA	0.00071
Molybdenum	29.0	ND	0.28
Nickel	230	0.00221	0.049
Selenium	29.0	0.00100	0.42
Silver	2.40	ND	0.00081
Thallium	1.30	0.000150	0.11
Uranium	42.0	0.00120	0.0025
Vanadium	370	0.00620	0.017
Zinc	1,200	0.0150	0.027
		Hazard Criterion:	1

Notes:

[a] The abiotic media exposure point concentrations used in the Tier I Background Livestock Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at background locations.

[b] Dose and HQ estimates for beef cattle preferentially used the maximum detected LCOPC concentration measured in upland vegetation from background sampling locations, where available, over plant tissue concentrations modeled from abiotic media.

Bold indicates exceedance of IDEQ's and USEPA's acceptable hazard criterion

NA - not applicable
ND - not detected
EPC - exposure point concentration
HQ - Hazard quotient
IDEQ - Idaho Department of Environmental Quality
LCOPC - livestock constituent of potential concern
mg/kg - milligrams per kilogram
mg/L - milligrams per liter
NOAEL - no observed adverse effects level
USEPA - U. S. Environmental Protection Agency

Table 6-24
Summary of Tier II Henry Site Hazard Estimates for Livestock

	EPC [a]		Livestock Hazard Estimates (HQ)
	Upland Soil (mg/kg)	**Surface Water (mg/L)**	**Beef Cattle[b]**
			NOAEL-Based Livestock Hazard Estimates
Molybdenum	16.8	0.0111	0.59
Selenium	46.4	0.102	0.93
Thallium	1.31	0.0000813	0.54
		Hazard Criterion:	1

Notes:

[a] The abiotic media exposure point concentrations used in the Tier II Henry Site Livestock Risk Assessment are equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration measured in samples collected from the Henry Site.

[b] Dose and HQ estimates for beef cattle preferentially used the detected LCOPC concentration measured in upland vegetation from background sampling locations, where available, over plant tissue concentrations modeled from abiotic media.

Bold indicates exceedance of IDEQ's and USEPA's acceptable hazard criterion

NA - not applicable
ND - not detected
EPC - exposure point concentration
HQ - Hazard quotient
IDEQ - Idaho Department of Environmental Quality
LCOPC - livestock constituent of potential concern
mg/kg - milligrams per kilogram
mg/L - milligrams per liter
NOAEL - no observed adverse effects level
USEPA - U. S. Environmental Protection Agency

Table 6-25
Summary of Tier II Background Hazard Estimates for Livestock

	EPC [a]		Livestock Hazard Estimates (HQ)
	Upland Soil (mg/kg)	**Surface Water (mg/L)**	**Beef Cattle[b]**
			NOAEL-Based Livestock Hazard Estimates
Molybdenum	7.94	NA	0.066
Selenium	6.67	0.000579	0.042
Thallium	0.510	0.000150	0.044
		Hazard Criterion:	1

Notes:

[a] The abiotic media exposure point concentrations used in the Tier II Background Livestock Risk Assessment are equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration measured in samples collected from Background

[b] Dose and HQ estimates for beef cattle preferentially used the detected LCOPC concentration measured in upland vegetation from background sampling locations, where available, over plant tissue concentrations modeled from abiotic media.

Bold indicates exceedance of IDEQ's and USEPA's acceptable hazard criterion

NA - not applicable
ND - not detected
EPC - exposure point concentration
HQ - Hazard quotient
IDEQ - Idaho Department of Environmental Quality
LCOPC - livestock constituent of potential concern
mg/kg - milligrams per kilogram
mg/L - milligrams per liter
NOAEL - no observed adverse effects level
USEPA - U. S. Environmental Protection Agency

Table 6-26
Summary of Tier I RME Henry Site and Background Cumulative Risk Estimates for Human Receptors

	Current/Future Native American				Hypothetical Future Resident				Current/Future Seasonal Rancher			
	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]
Upland Soil												
Site-Related	**1E-03**	As, Ra-226	**6**	V, U	**1E-03**	As, Ra-226	**6**	V, U	**2E-03**	As, Ra-226	1	--
Background	**5E-04**	As, Ra-226	**3**	V	**5E-04**	As, Ra-226	**3**	V	**9E-04**	As, Ra-226	0.8	
Riparian Soil												
Site-Related	**9E-06**	As	**4**	V	8E-07	--	0.3	--				
Background	**1E-05**	As	0.7	--	8E-07	--	0.06	--				
Culturally Significant Plant - Upland Soil												
Site-Related	**3E-03**	As, Ra-226	**22**	Cd, Co, Sb, Se, Tl								
Background	**3E-03**	As	**77**	As, Cd, Co, Mn, Ni, Sb, Se, Tl, V								
Culturally Significant Plant - Riparian Soil												
Site-Related	**4E-04**	As	**57**	As, Cd, Co, Mn, Ni, Sb, Se, Tl, V								
Background	**4E-04**	As	**19**	As, Cd, Co, Mn, Sb, Tl								
Aquatic Plant - Surface Water and Sediment												
Site-Related	**2E-03**	As, Ra-226	**82**	As, Cd, Mn, Ni, Sb, Se, Tl, U, V, Zn								
Background	**2E-04**	As, Ra-226	**6**	Cd								
Fruits and Vegetables - Upland Soil and Groundwater												
Site-Related					**1E-02**	As, Ra-226	**319**	As, Cd, Co, Mn, Mo, Ni, Sb, Se, Tl, U, V				
Background					**3E-03**	As, Ra-226	**70**	As, Cd, Co, Mn, Mo, Ni, Sb, Se, Tl, V				
Surface Water												
Site-Related	**4E-06**	As	0.7	--	6E-07	--	0.1	--				
Background	2E-07	--	0.02	--	3E-08	--	0.003	--				
Fish												
Site-Related	**8E-04**	As, Ra-226	**229**	As, Cd, Ni, Se, Tl, Zn	**8E-04**	As, Ra-226	**229**	As, Cd, Ni, Se, Tl, Zn				
Background	**4E-05**	As	**83**	Sb, Tl	**4E-05**	As	**83**	Sb, Tl				
Groundwater												
Site-Related					**1E-04**	As	**10**	Co, Mn, Se, Tl	**2E-05**	As	0.1	--
Background					**3E-05**	As	1	--	**5E-06**	As	0.02	--
Cattle - Upland Soil and Surface Water												
Site-Related									**2E-04**	As, Ra-226	**15**	Co, Se, Tl
Background									**8E-05**	As	**8**	Co, Tl

Table 6-26
Summary of Tier I RME Henry Site and Background Cumulative Risk Estimates for Human Receptors

	Current/Future Native American				Hypothetical Future Resident				Current/Future Seasonal Rancher			
	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]
Cattle - Upland Soil and Groundwater												
Site-Related									**9E-05**	As, Ra-226	**15**	Co, Se, Tl
Background									**9E-04**	As	**8**	Co, Tl
Elk - Upland Soil and Surface Water												
Site-Related	7E-07	--	0.04	--								
Background	6E-07	--	0.04	--								
Indoor Air												
Site-Related					**6E-02**	Rn-222	--	--				
Background					**5E-02**	Rn-222	--	--				

Notes:
[a] Media-specific cumulative ILCR and HI for all constituent of potential concern (COPCs).
[b] Analytes with a chemical-specific Incremental Tier I RME ILCR or hazard quotient (HQ) greater than the USEPA's risk management range and/or IDEQ's acceptable risk criteria are listed as media-specific risk drivers.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
NA - not applicable
RME - reasonable maximum exposure
USEPA - United States Environmental Protection Agency

Key:
As - arsenic
Cd - cadmium
Co - cobalt
Mo - molybdenum
Mn - manganese
Ni - nickel
Ra - radium
Rn - radon
Sb - antimony
Se - selenium
Tl - thallium
U - uranium
V- vanadium
Zn - zinc

Table 6-27
Summary of Tier II RME Henry Site Cumulative Incremental Risk Estimates for Human Receptors

	Current/Future Native American				Hypothetical Future Resident				Current/Future Seasonal Rancher				Current/Future Recreational Hunter				Current/Future Recreational Camper/Hiker				Current/Future Recreational Fishers			
	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]
Upland Soil																								
Site-Related	2E-04	As, Ra-226	2	--	2E-04	As, Ra-226	2	--	4E-04	As, Ra-226	0.4	--	1E-04	Ra-226	0.04	--	6E-05	Ra-226	0.04	--				
Background	9E-05	As, Ra-226	0.6	--	9E-05	As, Ra-226	0.6	--	2E-04	As, Ra-226	0.1	--	4E-05	Ra-226	0.013	--	2E-05	Ra-226	0.01	--				
Incremental	2E-04	As, Ra-226	1.1	--	2E-04	As, Ra-226	1.1	--	3E-04	As, Ra-226	0.2	--	6E-05	Ra-226	0.02	--	4E-05	Ra-226	0.03	--				
Riparian Soil																								
Site-Related	8E-06	As	0.6	--	NA	--	NA	--													NA	--	NA	--
Background	8E-06	As	0.2	--	NA	--	NA	--													NA	--	NA	--
Incremental	0E+00	--	0.4	--	NA	--	NA	--													NA	--	NA	--
Culturally Significant Plant - Upland Soil																								
Site-Related	7E-04	As, Ra-226	18	Cd, Co, Sb, Se, Tl																				
Background	8E-04	As, Ra-226	56	As, Cd, Co, Sb, Tl																				
Incremental	3E-04	Ra-226	2	Se																				
Culturally Significant Plant - Riparian Soil																								
Site-Related	3E-04	As	21	As, Cd, Co, Mn, Sb, Se, Tl, V																				
Background	3E-04	As	15	As, Co, Mn, Sb, Tl																				
Incremental	0E+00	--	7	Se, V																				
Aquatic Plant - Surface Water and Sediment																								
Site-Related	8E-04	As, Ra-226	30	As, Cd, Mn, Se, U, Zn																				
Background	2E-04	As, Ra-226	5	Cd																				
Incremental	5E-04	As, Ra-226	24	Cd, Se, U, Zn																				
Fruits and Vegetables - Upland Soil and Groundwater																								
Site-Related					2E-03	As, Ra-226	78	As, Cd, Co, Mo, Sb, Se, Tl																
Background					8E-04	As, Ra-226	42	As, Co, Mo, Sb, Tl																
Incremental					2E-03	As, Ra-226	64	As, Cd, Mo, Se, Tl																
Surface Water																								
Site-Related	2E-06	As	0.009	--	NA	--	NA	--	NA	--	NA	--									NA	--	NA	--
Background	1E-07	--	0.0007	--	NA	--	NA	--	NA	--	NA	--									NA	--	NA	--
Incremental	2E-06	As	0.008	--	NA	--	NA	--	NA	--	NA	--									NA	--	NA	--
Fish - Surface Water																								
Site-Related	3E-04	As, Ra-226	48	As, Cd, Se, Tl, Zn	3E-04	As, Ra-226	48	As, Cd, Se, Tl, Zn													3E-04	As, Ra-226	48	As, Cd, Se, Tl, Zn
Background	3E-05	As	76	Tl	3E-05	As	76	Tl													3E-05	As	76	Tl
Incremental	3E-04	As, Ra-226	7	As, Cd, Se, Zn	3E-04	As, Ra-226	7	As, Cd, Se, Zn													3E-04	As, Ra-226	7	As, Cd, Se, Zn
Groundwater																								
Site-Related					6E-05	As	4	Co, Tl	1E-05	As	0.05	--												
Background					2E-05	As	1	--	4E-06	As	0.01	--												
Incremental					4E-05	As	3	Co, Tl	8E-06	As	0.04	--												
Cattle - Upland Soil and Surface Water																								
Site-Related									7E-05	As, Ra-226	6	Tl												
Background									2E-05	As, Ra-226	3	Tl												
Incremental									5E-05	As, Ra-226	3	Tl												

Table 6-27
Summary of Tier II RME Henry Site Cumulative Incremental Risk Estimates for Human Receptors

	Current/Future Native American				Hypothetical Future Resident				Current/Future Seasonal Rancher				Current/Future Recreational Hunter				Current/Future Recreational Camper/Hiker				Current/Future Recreational Fishers			
	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]
Cattle - Upland Soil and Groundwater																								
Site-Related									**5E-05**	As, Ra-226	**7**	Tl												
Background									**2E-05**	As, Ra-226	**3**	Tl												
Incremental									**3E-05**	As, Ra-226	**4**	Tl												
Elk																								
Site-Related													NA	--	NA	--								
Background													NA	--	NA	--								
Incremental													NA	--	NA	--								
Indoor Air																								
Site-Related					**3E-02**	Rn-222	--																	
Background					**2E-02**	Rn-222	--																	
Incremental					**2E-02**	Rn-222	--																	

Notes:
[a] Media-specific cumulative ILCR and HI for all constituents of potential concern (COPCs) following the Tier I risk assessment.
[b] Analytes with a chemical-specific Incremental Tier II RME ILCR or hazard quotient (HQ) greater than the USEPA's risk management range and/or IDEQ's acceptable risk criteria are listed as media-specific risk drivers.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
RME - reasonable maximum exposure
USEPA - United States Environmental Protection Agency

Key:
As - arsenic
Cd - cadmium
Co - cobalt
Mn - manganese
Mo - molybdenum
Ra - radium
Rn - radon
Sb - antimony
Se - selenium
Tl - thallium
V- vanadium
Zn - zinc

Table 6-28
Ecological Risk Drivers for the Tier I Evaluation at the Henry Site and Background Locations

	Long-Tailed Vole	Elk	American Goldfinch	Deer Mouse	Raccoon	American Robin	Mallard	Mink	Coyote	Great Blue Heron	Northern Harrier
NOAEL-Based Ecological Hazard Estimates											
Site - Related:											
Hazard Range	< 0.1 - 333	< 0.1 - 0.55	< 0.1 - 164	< 0.1 - 166	< 0.1 - 9.6	< 0.1 - 60	< 0.1 - 16	< 0.1 - 722	< 0.1 - 6.6	< 0.1 - 101	< 0.1 - 3.7
Risk Drivers [a]	As Cd Cr Cu Mo Ni Sb Se Tl V Zn	--	As Cd Cr Cu Mo Ni Se V Zn	As Cd Cr Cu Mo Ni Sb Se Tl U V Zn	Al Se Tl	Cd Cr Cu Mo Ni Se V Zn	Al Se V	Al As Cd Cr Cu Mo Ni Sb Se Tl V Zn	Mo Se Tl U	Cd Ni Se Tl V Zn	Cr Mo Se V
Background:											
Hazard Range	< 0.1 - 29	< 0.1	< 0.1 - 31	< 0.1 - 29	< 0.1 - 4.4	< 0.1 - 180	< 0.1 - 3.2	< 0.1 - 314	< 0.1 - 5.1	< 0.1 - 1.0	< 0.1 - 2.3
Risk Drivers [a]	Cd Cr Mo Ni Sb Se Tl Zn	--	Cd Cr Cu Ni Se V Zn	Cd Cr Mo Ni Sb Se Tl U Zn	Al	Cd Cr Cu Ni Se V Zn	Al	Al Cr Cu Ni Sb Se Tl	Mo Se Tl	---	V

Notes:
[a] Risk drivers are analytes for which an analyte-specific greater than the USEPA's and IDEQ's acceptable criterion of one was calculated.

-- - not applicable
IDEQ - Idaho Department of Environmental Quality
NOAEL - no observed adverse effects level
USEPA - United States Environmental Protection Agency

Al - aluminum
As - arsenic
Cd - cadmium
Cr - chromium
Cu - copper
Mo - molybdenum
Ni - nickel
Sb - antimony
Se - selenium
Tl - thallium
U - uranium
V- vanadium
Zn - zinc

Table 6-29
Ecological Risk Drivers for the Tier II Evaluation at the Henry Site and Background Locations

	Long-Tailed Vole	American Goldfinch	Deer Mouse	Raccoon	American Robin	Mallard	Mink	Coyote	Great Blue Heron	Northern Harrier
NOAEL-Based Ecological Hazard Estimates										
Site - Related:										
Hazard Range	< 0.1 - 38	< 0.1 - 19	< 0.1 - 36	< 0.1 - 1.8	< 0.1 - 10	< 0.1 - 6.1	0.45 - 176	< 0.1 - 3.0	< 0.1 - 11	< 0.1 - 1.3
Risk Drivers [a]	Cr Mo Ni Se Tl	Cr Cu Mo Ni Se V	Cd Cr Cu Mo Ni Se Tl	Al	Cd Cr Cu Ni Se V Zn	Al Se V	Al Cd Cr Cu Mo Ni Se V Zn	Mo Se Tl	Se Zn	Se V
Background:										
Hazard Range	< 0.1 - 28	< 0.1 - 7.8	< 0.1 - 12	< 0.1 - 1.1	< 0.1 - 4.5	< 0.1 - 0.78	< 0.10 - 312	< 0.1 - 1.4	< 0.1 - 1.0	< 0.1 - 0.59
Risk Drivers [a]	Mo Sb Se Tl	Cr Se V	Cd Cr Mo Ni Sb Se Tl	Al	Cd Cr Se V	--	Al Cu Ni Sb Se Tl	Mo	--	--

Notes:

[a] Risk drivers are analytes for which an analyte-specific greater than the USEPA's and IDEQ's acceptable criterion of one was calculated. Ecological hazards for antimony in upland soil and antimony and thallium in riparian soil and sediment were greater at background locations than at Henry Site locations, and therefore antimony and thallium are not risk drivers in the indicated media.

-- - not applicable
IDEQ - Idaho Department of Environmental Quality
NOAEL - no observed adverse effects level
USEPA - United States Environmental Protection Agency

Al - aluminum
Cd - cadmium
Cr - chromium
Cu - copper
Mo - molybdenum
Ni - nickel
Sb - antimony
Se - selenium
Tl - thallium
V- vanadium
Zn - zinc

Table 6-30
Livestock Risk Drivers for the Tier I and Tier II Evaluations at the Henry Site and Background Locations

	Tier I NOAEL-Based	Tier II-NOAEL-Based
Site - Related:		
Hazard Range	< 0.001 - 8.2	0.54 - 0.93
Risk Drivers [a]	Mo, Se, Tl	--
Background:		
Hazard Range	< 0.001 - 0.70	0.042 - 0.066
Risk Drivers [a]	--	--

Notes:
[a] Risk drivers are analytes for which an analyte-specific greater than the USEPA's and IDEQ's acceptable criterion of one was calculated.

-- - not applicable
IDEQ - Idaho Department of Environmental Quality
NOAEL - no observed adverse effects level
USEPA - United States Environmental Protection Agency

mo - molybdenum
se - selenium
Tl - thallium

SECTION 7.0 TABLES

TABLE 7-1
SUMMARY OF HUMAN HEALTH PRELIMINARY CONTAMINANTS OF CONCERN [a] BASED ON THE SITE BRA

Constituent [b]	Direct Exposure				Indirect Exposure [c]											
					Culturally Significant Plants [f]					Fruits and Vegetables [g]			Cattle [h]			Fish [i]
	Upland Soil	Riparian Soil	Surface Water [d]	Ground-water [e]	Modeled from Upland Soil	Measured Upland Plant	Modeled from Riparian Soil	Measured Riparian Plant	Sediment & Surface Water	Modeled from Upland Soil	Modeled from Ground water	Measured Upland Plant	Upland Soil	Surface Water	Ground-water	Surface Water & Sediment
Antimony																
Arsenic	X		X	X					X	X	X	X	X	X		
Cadmium									X	X		X				
Chromium																
Cobalt				X												
Manganese																
Molybdenum												X				
Nickel																
Radium-226	X				X				X	X			X			
Radon-222	X [j]															
Selenium						X		X	X			X				
Thallium				X						X		X	X			
Uranium									X							
Vanadium							X									
Zinc									X							

Notes:

[a] Constituents with a chemical-specific incremental Tier II reasonable maximum exposure (RME) incremental lifetime cancer risk (ILCR) or hazard quotient (HQ) greater than USEPA's risk management range ($ILCR>1x10^{-6}$ and HQ>1) and/or IDEQ's acceptable risk criteria ($1x10^{-5}$ and HQ>1) for any human receptor are denoted as a preliminary contaminant of concern (COC) with an "X" in the applicable media.

[b] Constituents in this column were first identified as a human health constituent of "potential" concern (COPC) in one or more media.

[c] All media-specific COPCs were evaluated for the indirect pathways indicated in Figure 6-1 in addition to direct exposure pathways (i.e., ingestion, inhalation, and dermal contact) except sediment COPCs, which were evaluated through the indirect uptake to aquatic culturally significant plant pathway only. The indirect exposure route - ingestion of elk tissue - was not evaluated in the Tier II risk assessment due to the absence of excess Tier I risk or hazard.

[d] Dissolved concentrations of metals in surface water were used in human health risk and hazard calculations for all analytes except for selenium, where the total surface water concentrations were used.

[e] Total concentrations of metals in groundwater were used in human health risk and hazard calculations for all analytes.

[f] The indirect exposure routes - ingestion of culturally significant plants grown in upland and riparian soil - were evaluated using measured concentrations of constituents in upland and riparian culturally significant plant species where available, rather than modeled concentrations from soil; chemicals identified as preliminary COCs based on plant tissue concentrations from upland or riparian plants are indicated as preliminary COCs in the respective upland or riparian soil. The indirect exposure route - ingestion of aquatic culturally significant plants - was evaluated for sediment COPCs by modeling uptake from sediment only, as no aquatic plant tissue data are available. Although all culturally significant plant tissue concentrations were modeled from sediment, both sediment and surface water COPCs were evaluated for this pathway.

TABLE 7-1
SUMMARY OF HUMAN HEALTH PRELIMINARY CONTAMINANTS OF CONCERN [a] BASED ON THE SITE BRA

[g] The indirect exposure route - ingestion of fruits and vegetables grown in upland soil and irrigated with groundwater - was evaluated for all soil and groundwater COPCs. For an analyte that was a COPC in soil only, the measured non-culturally significant plant concentration, when available, or the plant concentration modeled from soil when measured tissue data were not available, was used to represent the fruits and vegetables concentration. If an analyte was a COPC in groundwater, the fruits and vegetables exposure concentration was equal to the modeled concentration from groundwater plus either the measured non-culturally significant plant concentration when available, or the modeled concentration from soil. Fruit and vegetable preliminary COCs resulting from elevated measured metals concentrations plant tissues are indicated as preliminary COCs in upland soil as well as in measured plants.

[h] The indirect exposure route - ingestion of cattle grazed on upland pasture - was evaluated with either surface or groundwater ingestion. Excess hazard was associated with uptake to cattle tissue from soil rather than from livestock drinking water. Excess human health risk due to arsenic in cattle tissue resulted from both pasture and livestock drinking water.

[i] Although fish tissue concentrations were modeled from surface water locations for all metals, this pathway was evaluated for all surface water and sediment COPCs.

[j] Radon-222 was evaluated for indoor air exposure only; receptors are not directly exposed to radon-222 in upland soil.

X - preliminary contaminant of concern (preliminary COC)

TABLE 7-2
RISK CONCLUSION SUMMARY BY MEDIUM

Medium	Nature and Extent	Receptor Exposures - Identified Preliminary COCs[a] and Affected Human Receptors	Feasibility Study
Upland Soil	Adequately characterized, no additional investigation needed	Direct Exposure - **As, Ra-226** Native American Hypothetical Future Resident Seasonal Rancher Direct Exposure - **Ra-226** Recreational Hunter Recreational Camper/Hiker Indoor Air Exposure - **Rn-222** Hypothetical Future Resident	Sufficient information to evaluate remedial alternatives, no additional investigation needed
Upland Vegetation	Adequately characterized, no additional investigation needed	Indirect Exposure Culturally Significant Plants[b] - **Se, Ra-226** Native American Indirect Exposure Fruits and Vegetables[c] - **As, Cd, Mo, Se, Tl, Ra-226** Hypothetical Future Resident	Sufficient information to evaluate remedial alternatives, no additional investigation needed
Riparian Vegetation	Adequately characterized, no additional investigation needed	Indirect Exposure Culturally Significant Plants[b] - **Se, V** Native American Indirect Exposure Aquatic Plants[d] - **As, Cd, Se, U, Zn, Ra-226** Native American	Sufficient information to evaluate remedial alternatives, no additional investigation needed
Riparian Soil and Sediment	Adequately characterized, no additional investigation needed	Direct Exposure - **None** Indirect Exposure - see riparian vegetation	Sufficient information to evaluate remedial alternatives, no additional investigation needed

TABLE 7-2
RISK CONCLUSION SUMMARY BY MEDIUM

Medium	Nature and Extent	Receptor Exposures - Identified Preliminary COCs[a] and Affected Human Receptors	Feasibility Study
Surface Water	Adequately characterized, no additional investigation needed	Direct Exposure - **As** Native American Fail Screening Criteria[e] **- As, Cd, Ni, Se, Tl, Zn**	Sufficient information to evaluate remedial alternatives, no additional investigation needed
Groundwater	Adequately characterized, no additional investigation needed	Direct Exposure - **As, Co, Tl** Hypothetical Future Resident Direct Exposure - **As** Seasonal Rancher Fail Screening Criteria[e] - **Cd, Se**	Sufficient information to evaluate remedial alternatives, no additional investigation needed
Biota	Adequately characterized, no additional investigation needed	Indirect Exposure Fish[f] - **None** Native American Hypothetical Future Resident Recreational Fishers Indirect Exposure Cattle[g] - **As, Ra-226, Tl** Seasonal Rancher	Sufficient information to evaluate remedial alternatives, no additional investigation needed

Notes:
[a] Preliminary COCs based on direct and indirect risk as presented on Table 7-1. Preliminary COECs as referenced in Section 7.0 are presented on Table 7-3.
[b] Ingestion of culturally significant plants, grown in upland and riparian soil, was evaluated using measured concentrations in upland and riparian culturally significant plant species where available.
[c] Ingestion of fruits and vegetables, grown in upland soil and irrigated with groundwater, was evaluated for all soil and groundwater constituents of potential concern using measured concentrations in plant species where available.
[d] Ingestion of aquatic culturally significant plants was evaluated for sediment COPCs by modeling uptake from sediment only, as no aquatic plant tissue data are available.
[e] Surface water criteria are based on Idaho Water Quality Standards (IDAPA 58.01.02) or USEPA National Recommended Water Quality Criteria. Groundwater criteria are based on Idaho Groundwater Standards (IDAPA 58.01.11) or USEPA primary MCLs).
[f] Ingestion of fish was evaluated for both surface water or sediment constituents of potential concern; Tier II fish tissue concentrations were modeled from surface water.
[g] Ingestion of cattle grazed on upland pasture was evaluated in two scenarios, assuming either surface or groundwater ingestion.

TABLE 7-3
SUMMARY OF PRELIMINARY CONTAMINANTS OF ECOLOGICAL CONCERN [a] BASED ON THE SITE BRA

Constituent [b]	Upland Soil	Riparian Soil	Surface Water [c]	Sediment
Aluminum			X	
Antimony				
Arsenic				
Barium			[d]	
Boron			X	
Cadmium	X		X	X
Chromium	X	X		
Cobalt				
Copper	X	X		
Manganese			X	
Mercury				
Molybdenum	X	X		
Nickel	X	X	X	X
Selenium	X	X	X	X
Silver				
Thallium	X			
Uranium			X	
Vanadium	X	X	X	
Zinc	X		X	X

Notes:

[a] Constituents with a chemical-specific Tier II no observed adverse effects level (NOAEL)-based cumulative effects ecological hazard greater than USEPA's and IDEQ's acceptable hazard criterion of 1 for any ecological receptor are denoted as preliminary contaminants of ecological concern (COECs) with an "X" in the applicable media.

[b] Constituents in this column were first identified as constituents of "potential" ecological concern (COPEC) in one or more media.

[c] Dissolved concentrations of metals in surface water were used in ecological hazard calculations for all analytes except for selenium, where the total surface water concentrations were used.

[d] Barium HQ exceeds 1 as shown on Table 6-16. However, as Site concentrations do not exeed background concentrations, it is not considered a preliminary COEC.

X - preliminary contaminant of ecological concern (preliminary COEC)

TABLE 7-4
ECOLOGICAL SUMMARY BY INDICATOR SPECIES

Mammalian Receptor HQ Range

Medium	Long-Tailed Vole	Deer Mouse	Raccoon	Mink	Coyote	Elk	Beef Cattle
Site-Related	< 0.1 - **38**	< 0.1 - **36**	< 0.1 - **1.8**	0.45 - **176**	< 0.1 - **3.0**	NA	0.54-0.93
Background	< 0.1 - **28**	< 0.1 - **12**	< 0.1 - **1.1**	0.10 - **312**	< 0.1 - **1.4**	NA	0.042-0.066

Avian Receptor HQ Range

	American Goldfinch	American Robin	Mallard Duck	Great Blue Heron	Northern Harrier
Site-Related	< 0.1 - **19**	< 0.1 - **10**	< 0.1 - **6.1**	< 0.1 - **11**	< 0.1 - **1.3**
Background	< 0.1 - **7.8**	< 0.1 - **4.5**	< 0.1 - 0.78	< 0.1 - 1.0	< 0.1 - 0.59

Notes:
Risk drivers are COPECs for which an HQ greater than the USEPA's and IDEQ's acceptable criterion of 1 was calculated and include Al, Cd, Cr, Cu, Mo, Ni, Sb, Se, Tl, V, and Zn.
Bold indicates exceedance of IDEQ's and USEPA's acceptable ecological hazard criteria.
NA – Not Applicable

TABLE 7-5 FINAL SUMMARY OF CONTAMINANTS OF CONCERN AND CONTAMINANTS OF ECOLOGICAL CONCERN					
COC/COEC	**Upland Soil**	**Riparian Soil[a]**	**Sediment[a]**	**Surface Water**	**Groundwater**
Aluminum					
Antimony					
Arsenic	X[c]		X[c]	X[c]	
Barium					
Boron					
Cadmium	X[d]		X[d]	X[d]	X[e]
Chromium	X[b]	X[b]			
Cobalt					
Copper	X[b]	X[b]			
Iron					
Manganese					
Mercury					
Molybdenum	X[d]	X[b]			
Nickel	X[b]	X[b]	X[b]		
Radium-226	X[c]		X[c]		
Radon-222	X[c]				
Selenium	X[d]	X[d]	X[d]	X[d]	X[e]
Silver					
Sulfate					
Total Dissolved Solids					
Thallium	X[d]				
Uranium			X[c]		
Vanadium	X[b]	X[d]			
Zinc	X[b]		X[d]		

Notes:

[a] Because sediment and riparian soil are adjacent and contiguous throughout the Site, a combined sediment-riparian soil contaminant of concern/contaminant of ecological concern (COC/COEC) list is proposed.

[b] **X** - Identified as a COEC

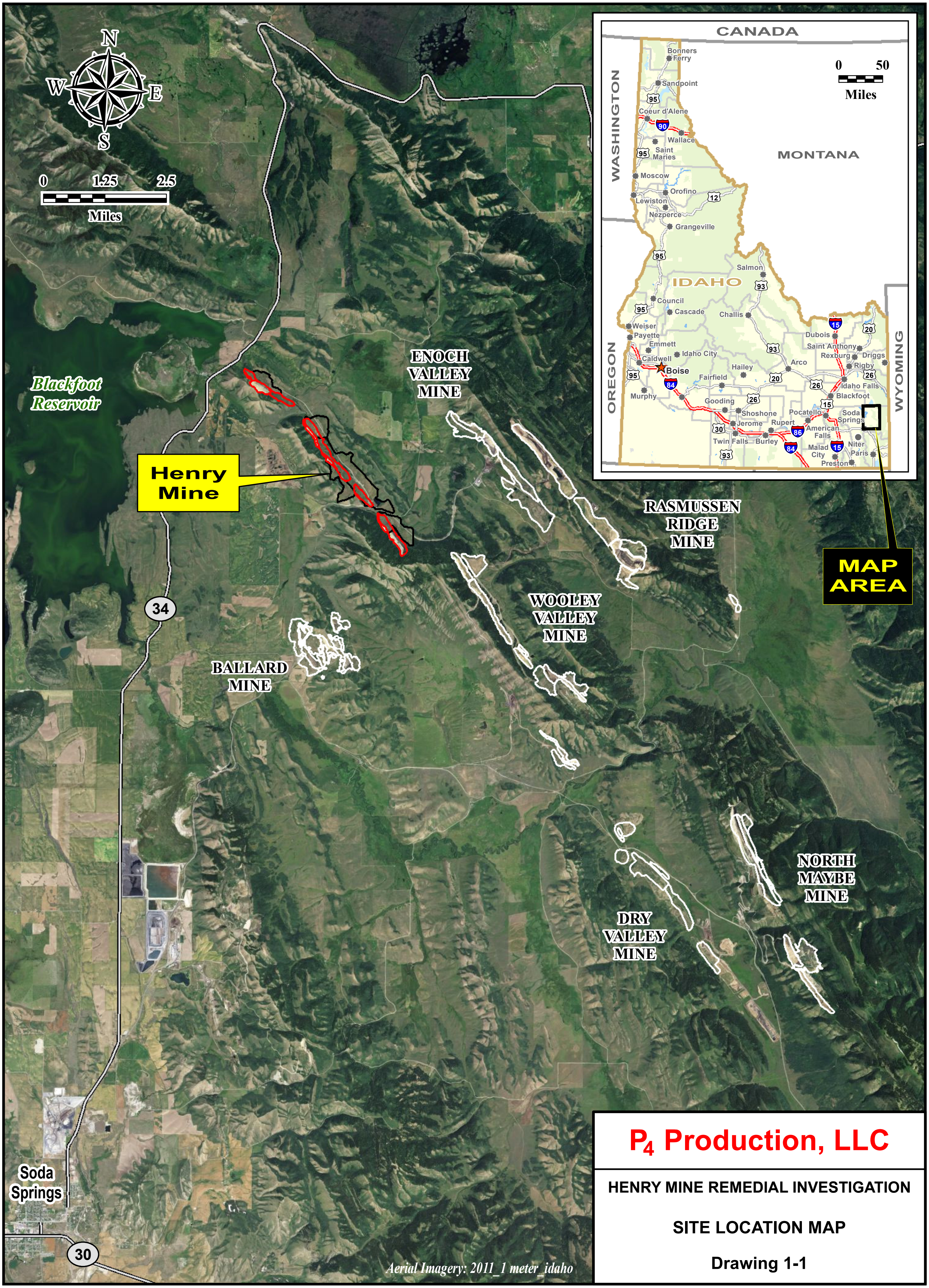
[c] **X** - Identified as a COC

[d] **X** - Identified as a COC and COEC

[e] **X** - Identified as a COC/COEC based on screening criteria

DRAWINGS

SECTION 1.0 DRAWINGS



P4 Production, LLC

HENRY MINE REMEDIAL INVESTIGATION

SITE LOCATION MAP

Drawing 1-1

DRAWN BY D. Severson

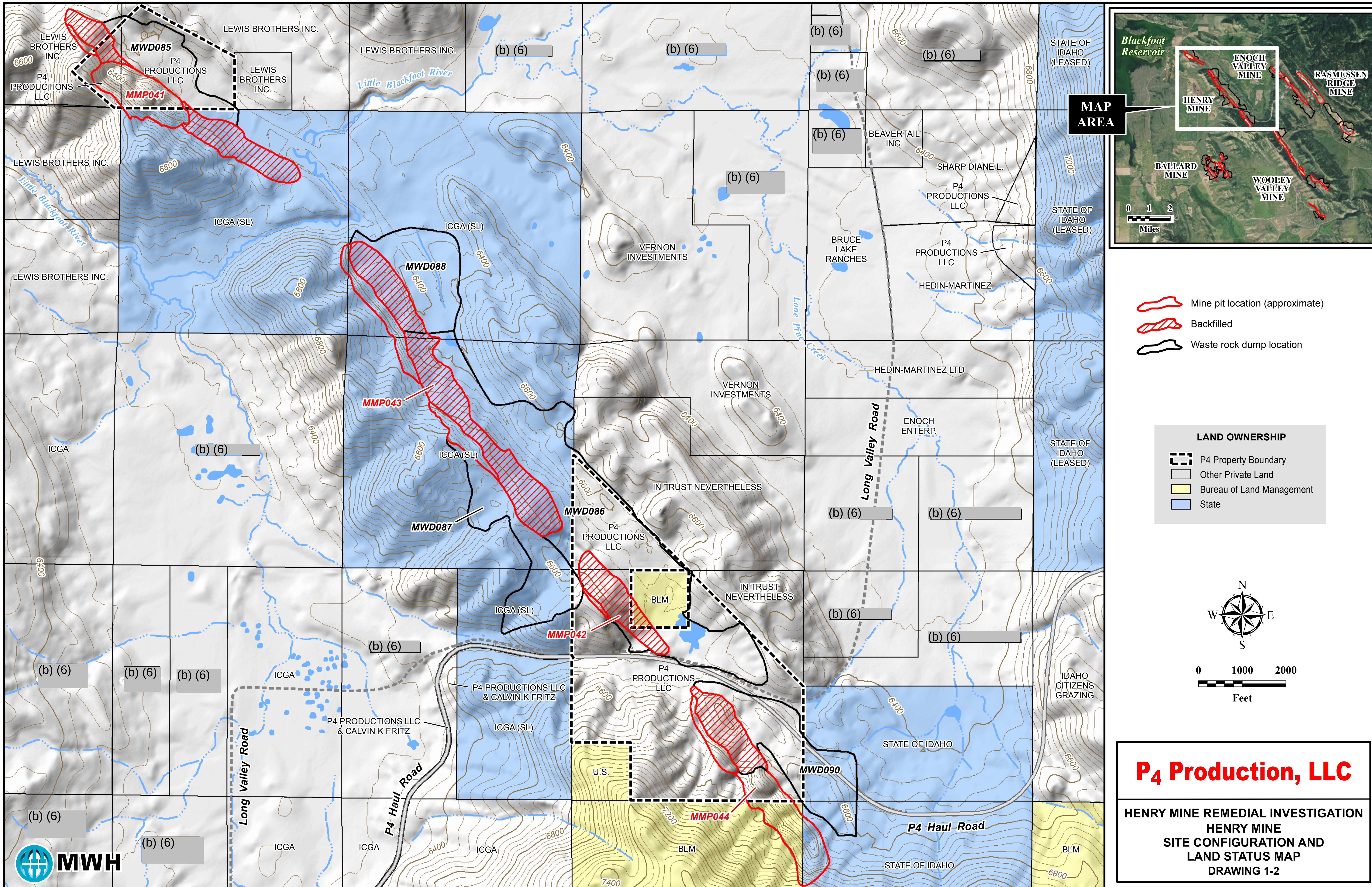
8 Dec 2015

C:\MWH\P4 Monsanto\HENRY_RI_Dec2015\FIGURES\Dwg 1-1_Site Location Map_Dec2015.mxd

DRAWN BY D. Severson

15 Feb 2016

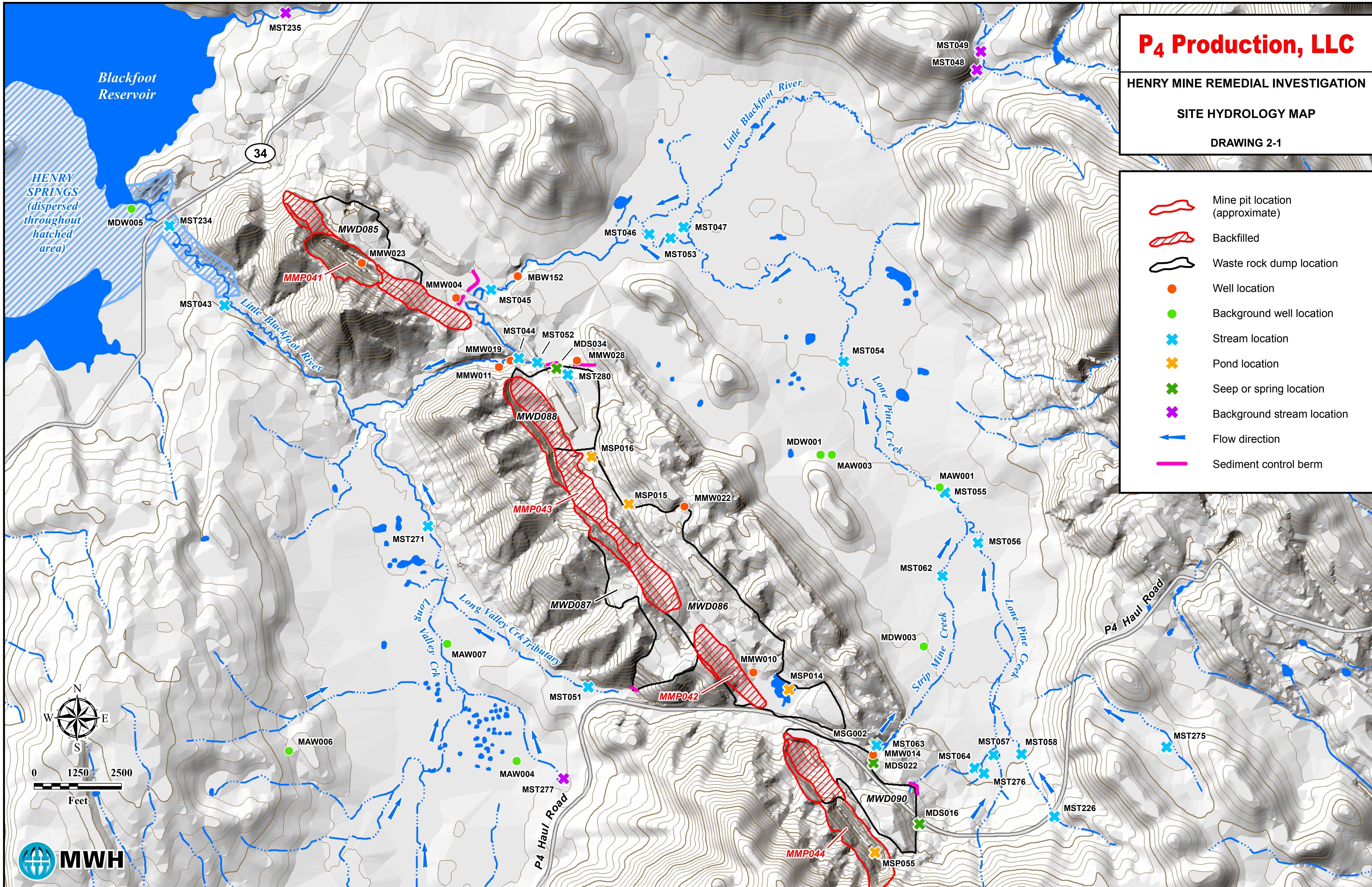
C:\Data\MWH\P4 Monsanto\HENRY_RI_Dec2015\FIGURES\Dwg 1-2_Henry Mine_Site Config and Land Status Map_15Feb2016.mxd



P_4 Production, LLC

HENRY MINE REMEDIAL INVESTIGATION
HENRY MINE
SITE CONFIGURATION AND
LAND STATUS MAP
DRAWING 1-2

SECTION 2.0 DRAWINGS



DRAWN BY D. Severson

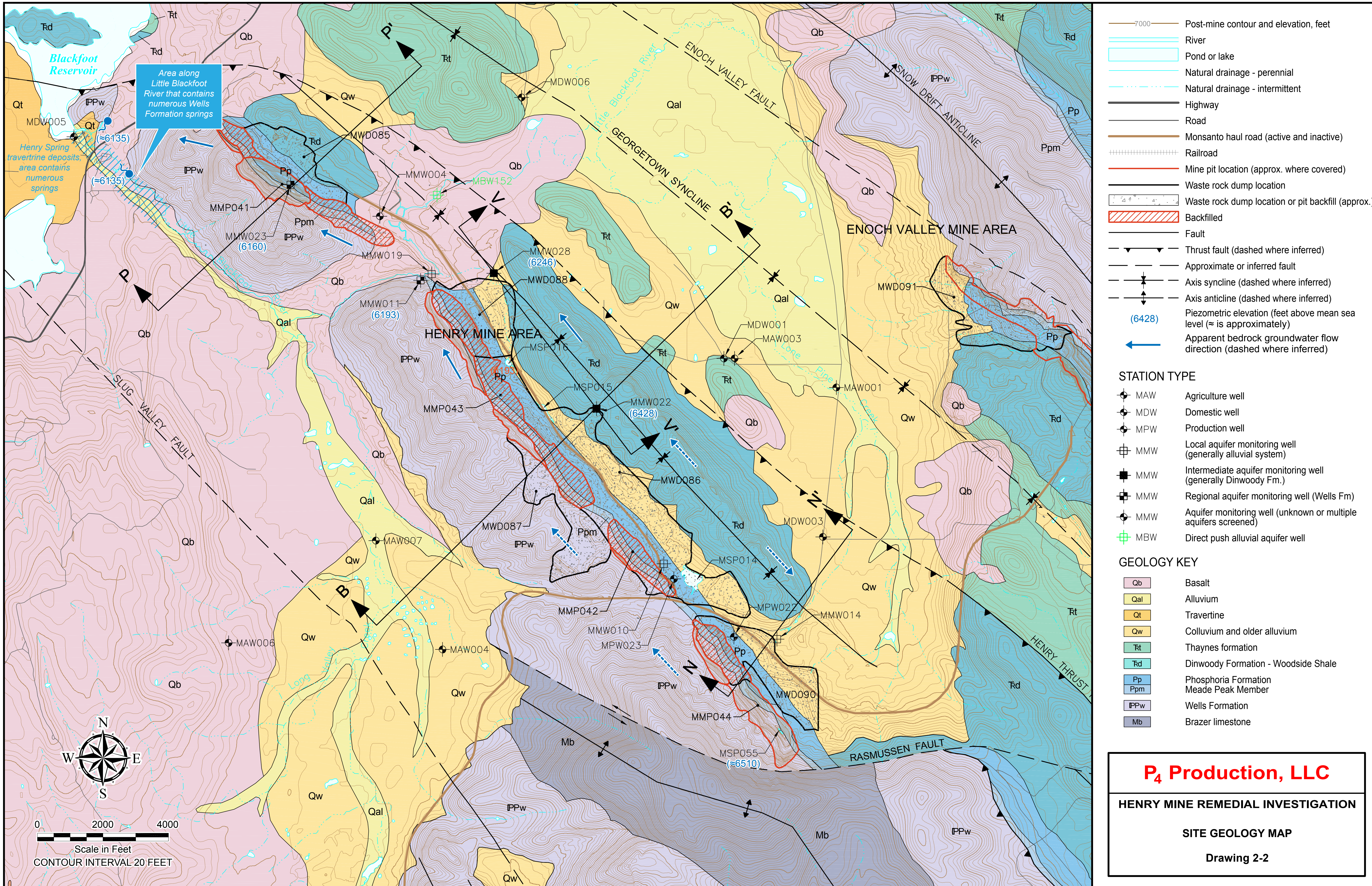
17 July 2017

C:\Data\MWH\P4 Monsanto\HENRY_RI_Dec2015\FIGURES\Dwg 2-1_Site Hydrology Map_17Jul2017.mxd

DRAWN BY D. Severson

5 June 2017

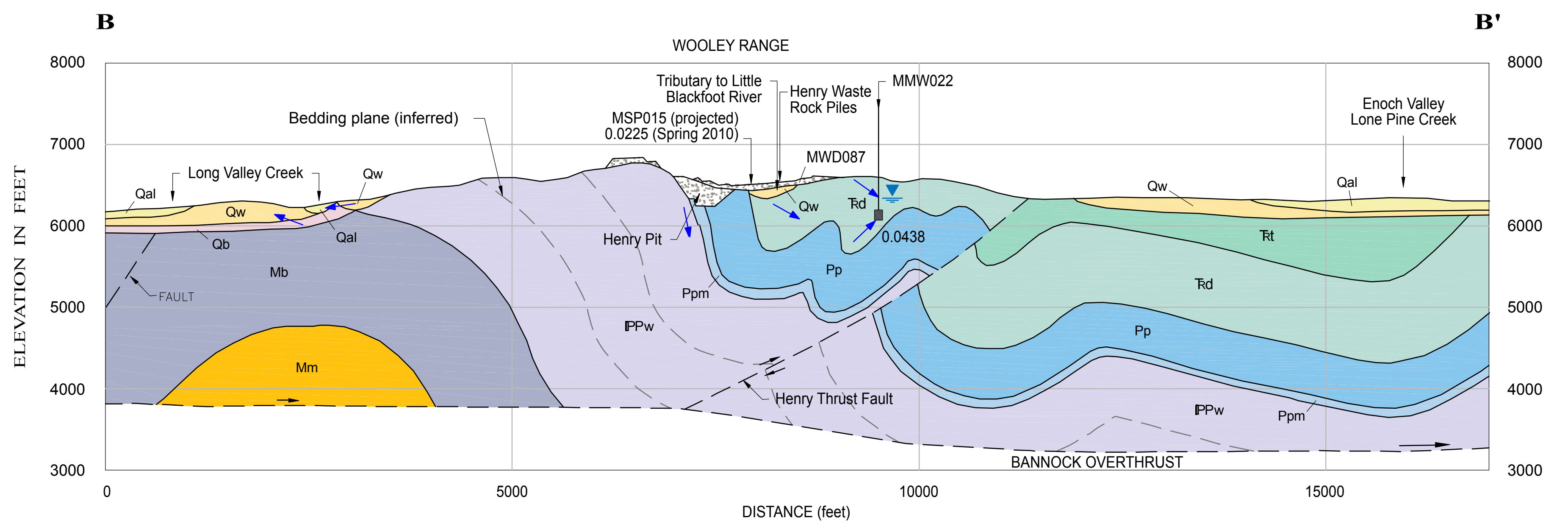
C:\Data\MWH\P4 Monsanto\HENRY_RI_Dec2015\FIGURES\Dwg 2-2_Henry Mine_Site Geology Map_5Jun2017.ai



DRAWN BY D. Severson

3 June 2017

C:\MWH\P4 Monsanto\HENRY_RI_Dec2015\FIGURES\Dwg 2-3_Henry Mine_Cross Section_B-B_Landscape_3Jun2017.ai



SECTION B-B'

0 1000 2000

Horizontal and Vertical Scale in Feet
NO VERTICAL EXAGGERATION

Waste rock

Pre-mine surface
(where different from current surface)

Geologic contact
(dashed where approximate or inferred)

Fault, showing direction of displacement
(dashed where inferred)

Schematic groundwater flow vector

6236' Measured groundwater elevation
(feet above mean sea level)

0.017 Measured total selenium concentration in mg/L
(spring 2014 sample, unless otherwise noted)

Monitoring well location showing approximate
screen location

GEOLOGY KEY

Symbol	Unit
Qb	Basalt
Qal	Alluvium
Qw	Colluvium and older alluvium
Ŧt	Thaynes formation
Ŧd	Dinwoody Formation - Woodside Shale
Pp	Phosphoria Formation
Ppm	Meade Peak Member
IPPw	Wells Formation
Mb	Brazer limestone
Mm	Madison limestone

NOTES

1. *Adapted from Mansfield (1927).*
2. *Mine pit and waste rock are shown schematically.*
3. *Section line indexed on Drawing 2-2.*
4. *Data for all sampling events are tabulated in Appendix B.*

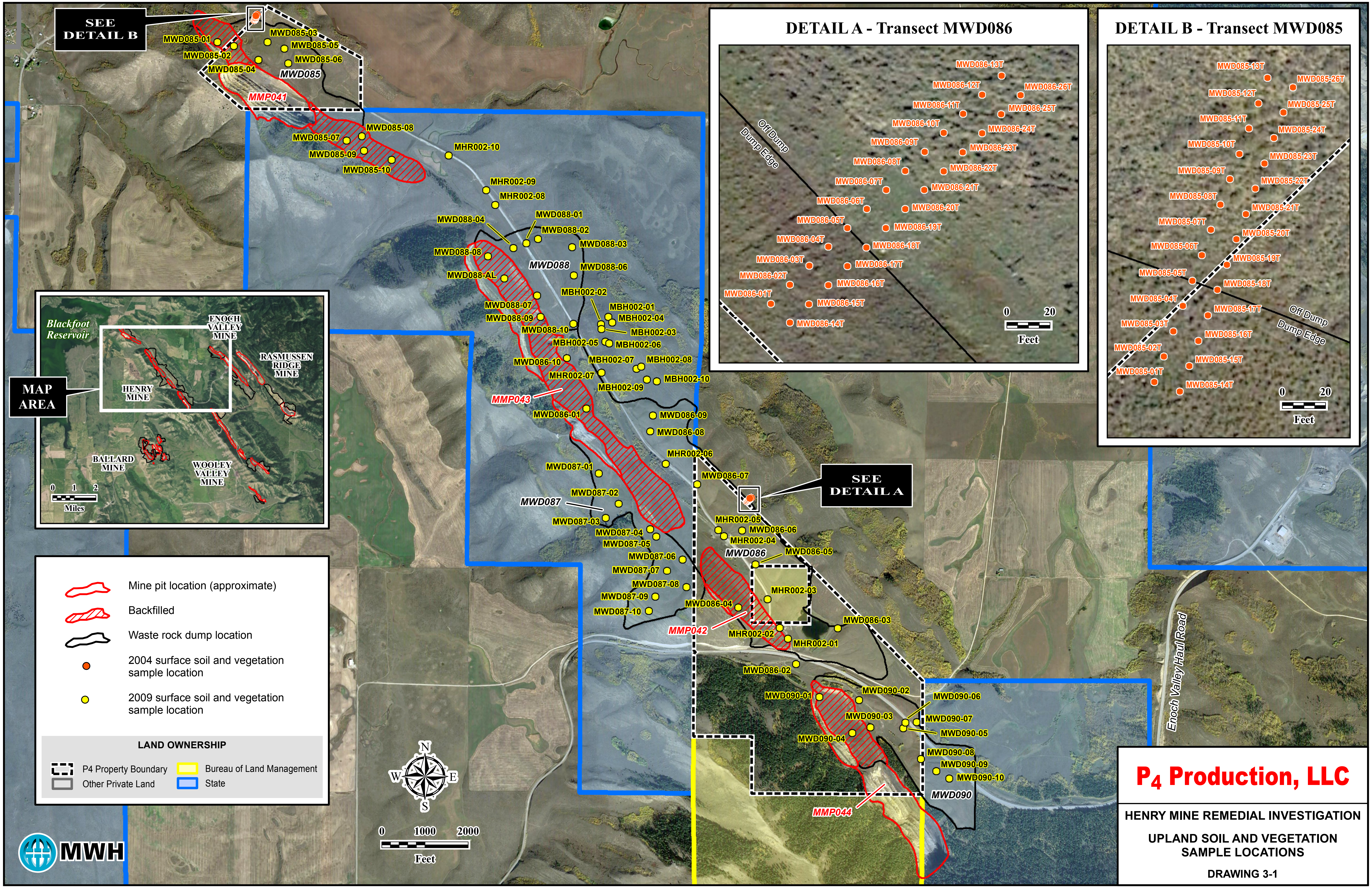
P_4 Production, LLC

HENRY MINE REMEDIAL INVESTIGATION

SCHEMATIC GEOLOGIC CROSS SECTION B-B'

Drawing 2-3

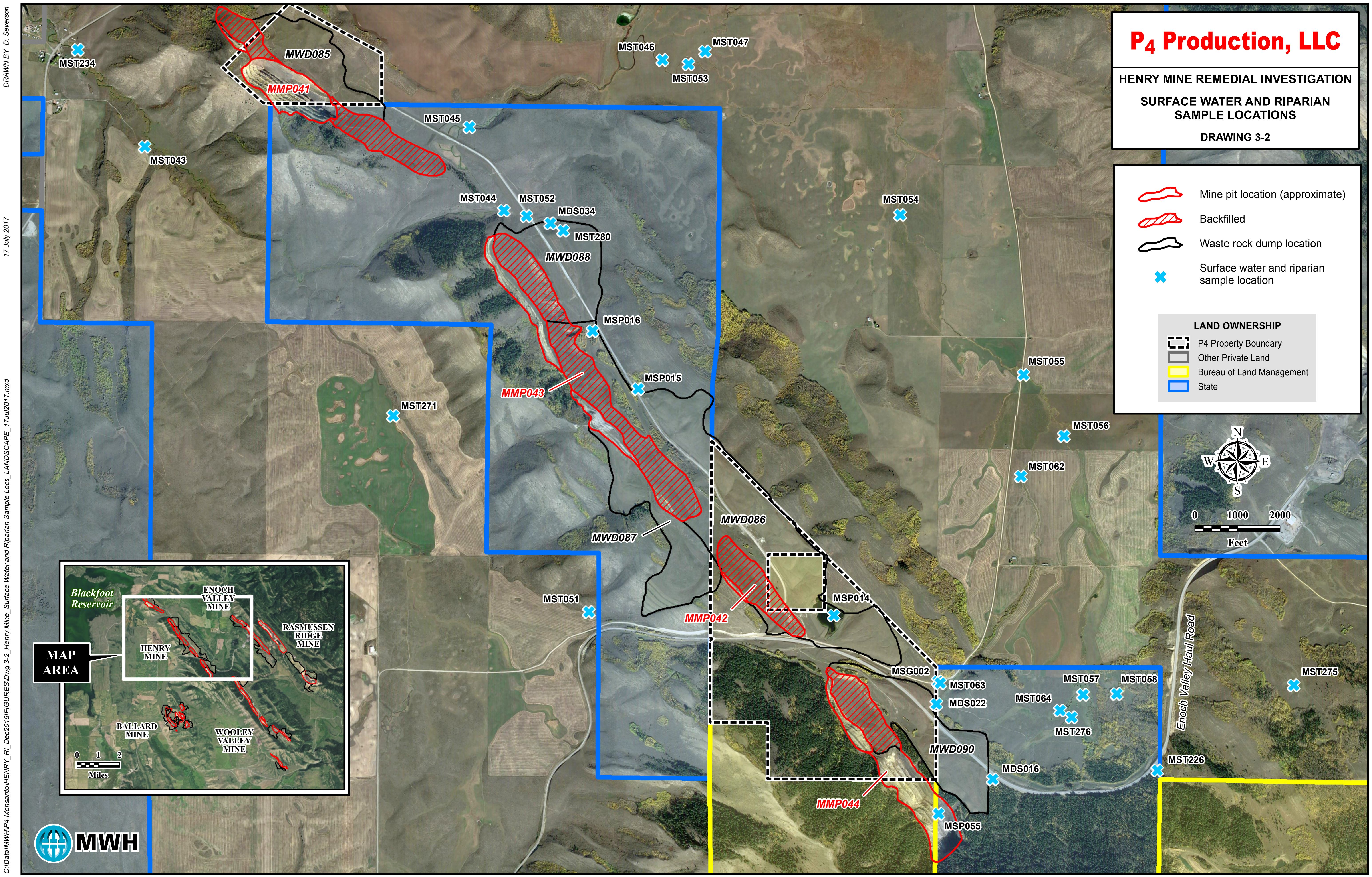
SECTION 3.0 DRAWINGS

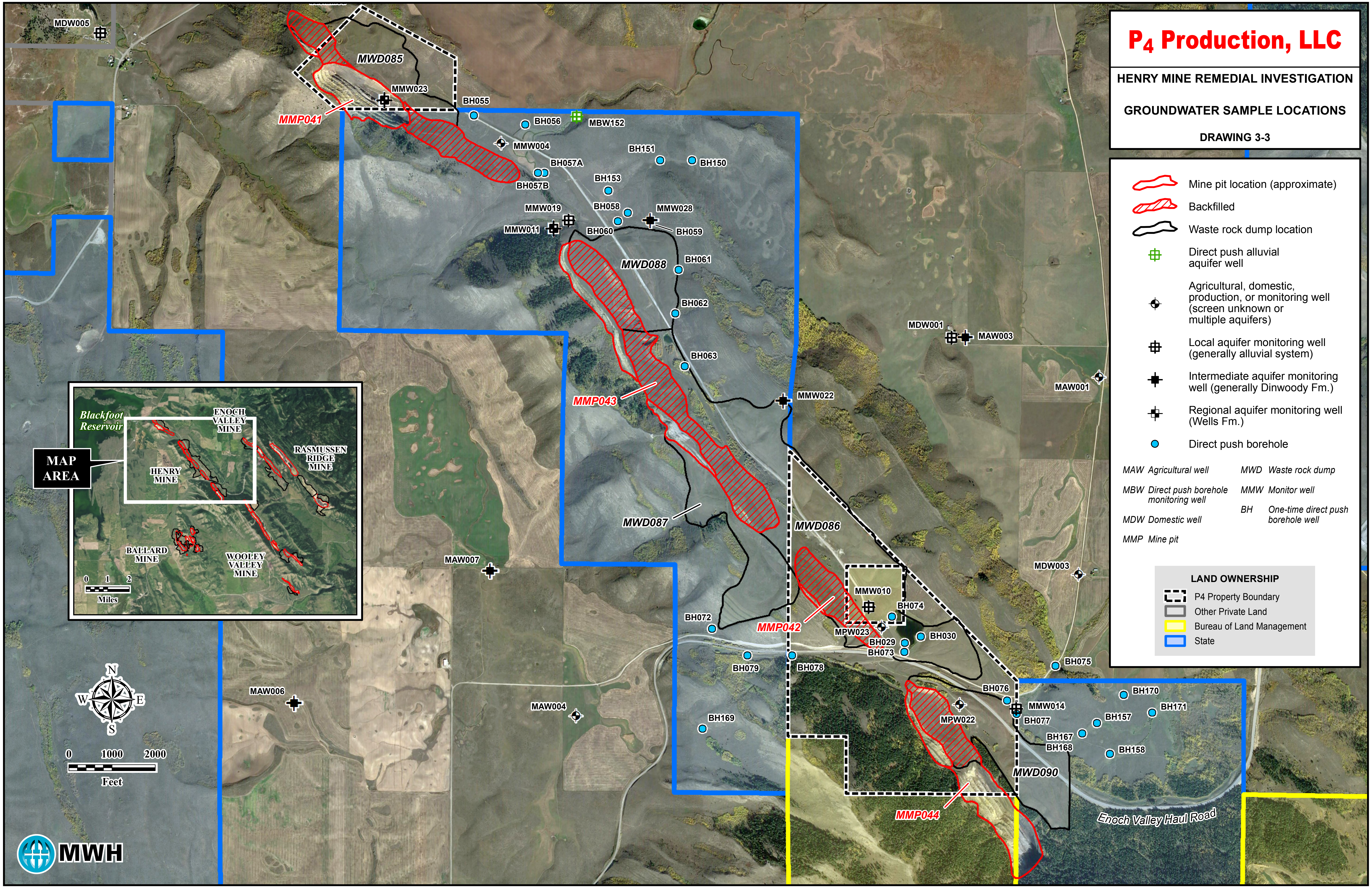


DRAWN BY D. Severson

25 May 2016

C:\Data\MWH\P4 Monsanto\HENRY_RI_Dec2015\FIGURES\Dwg 3-1_Henry Mine_Upland Soil and Veg Sample Locs_LANDSCAPE_25May2016.mxd


P4 Production, LLC
HENRY MINE REMEDIAL INVESTIGATION
SURFACE WATER AND RIPARIAN SAMPLE LOCATIONS
DRAWING 3-2
Mine pit location (approximate)
Backfilled
Waste rock dump location
Surface water and riparian sample location
LAND OWNERSHIP
P4 Property Boundary
Other Private Land
Bureau of Land Management
State
N
E
S
W
0
1000
2000
Feet
MST234
MWD085
MMP041
MST046
MST047
MST053
MST045
MST043
MST044
MST052
MDS034
MST280
MWD088
MST054
MSP016
MSP015
MMP043
MST271
MST055
MST056
MST062
MWD086
MWD087
MST051
MMP042
MSP014
MSG002
MST063
MDS022
MST064
MST057
MST058
MST276
MST275
MWD090
MDS016
MST226
MMP044
MSP055
Enoch Valley Haul Road
Blackfoot Reservoir
ENOCH VALLEY MINE
RASMUSSEN RIDGE MINE
HENRY MINE
MAP AREA
BALLARD MINE
WOOLEY VALLEY MINE
0 1 2
Miles
MWH
DRAWN BY D. Severson
17 July 2017
C:\Data\MWH\P4 Monsanto\HENRY_RI_Dec2015\FIGURES\Dwg 3-2_Henry Mine_Surface Water and Riparian Sample Locs_LANDSCAPE_17Jul2017.mxd

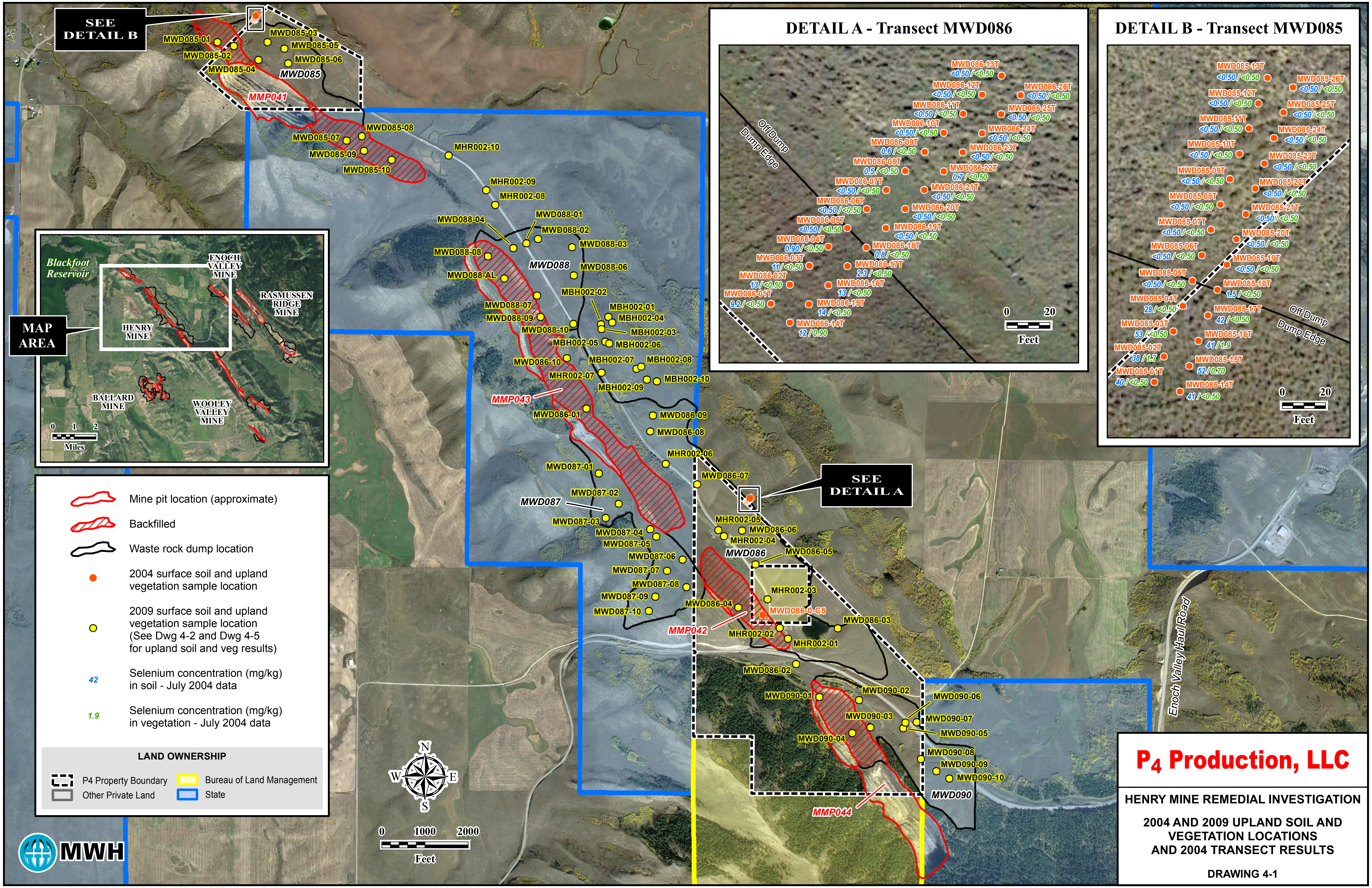


DRAWN BY D. Severson

28 Feb 2017

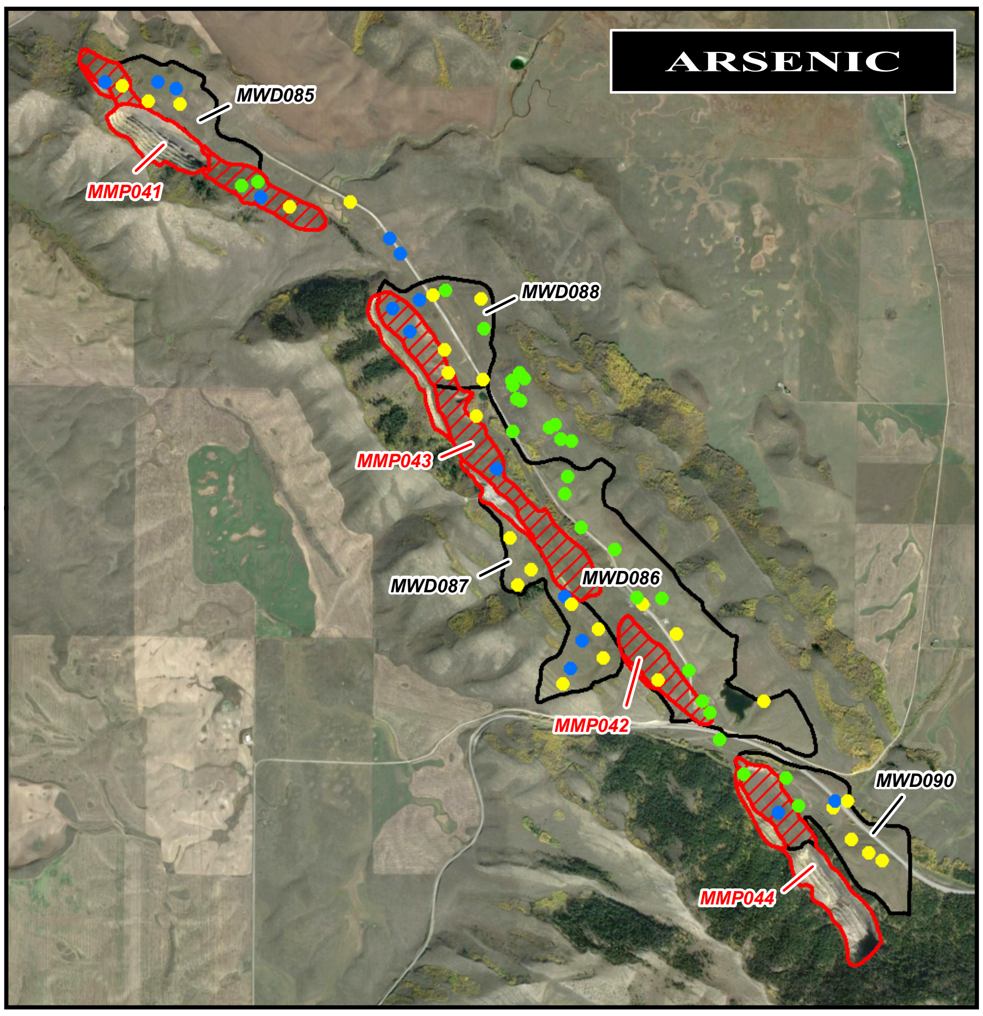
C:\Data\MWH\P4 Monsanto\HENRY_RI_Dec2015\FIGURES\Dwg 3-3_Henry Mine_Groundwater Sample Locs_LANDSCAPE_28Feb2017.mxd

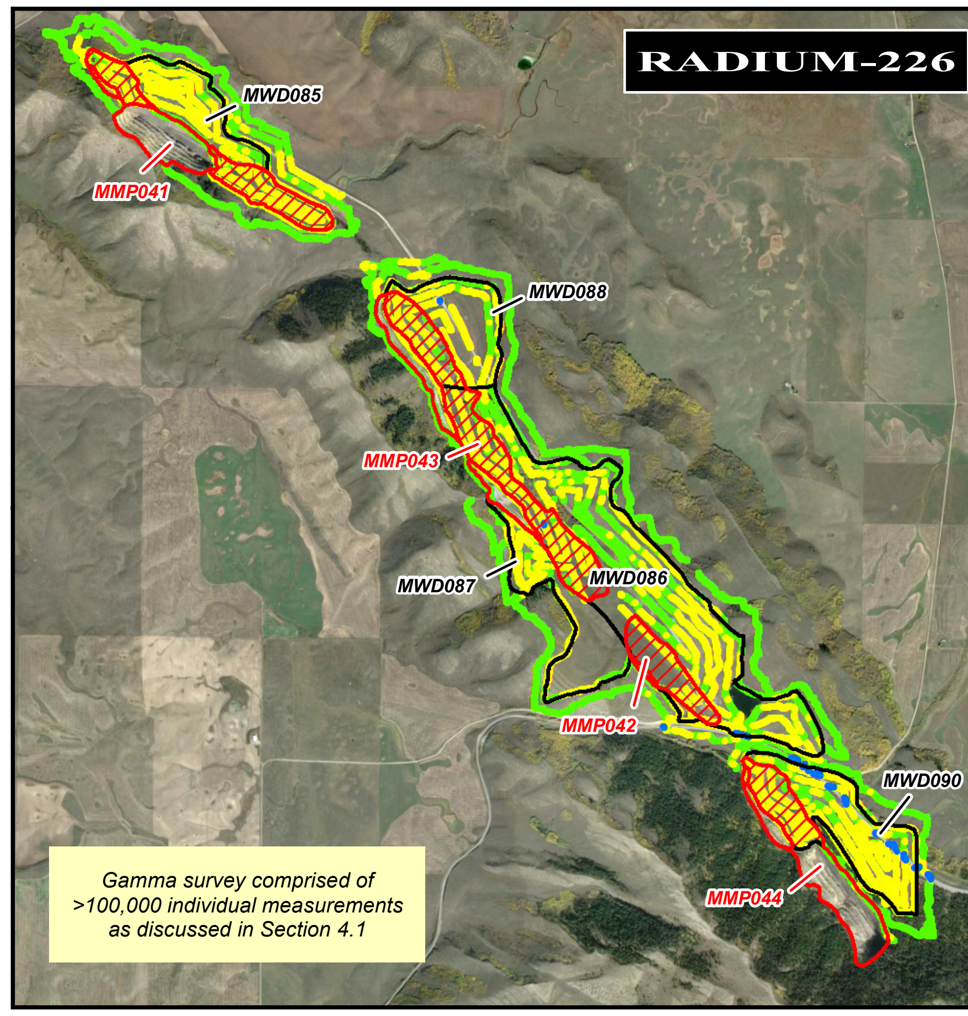
SECTION 4.0 DRAWINGS

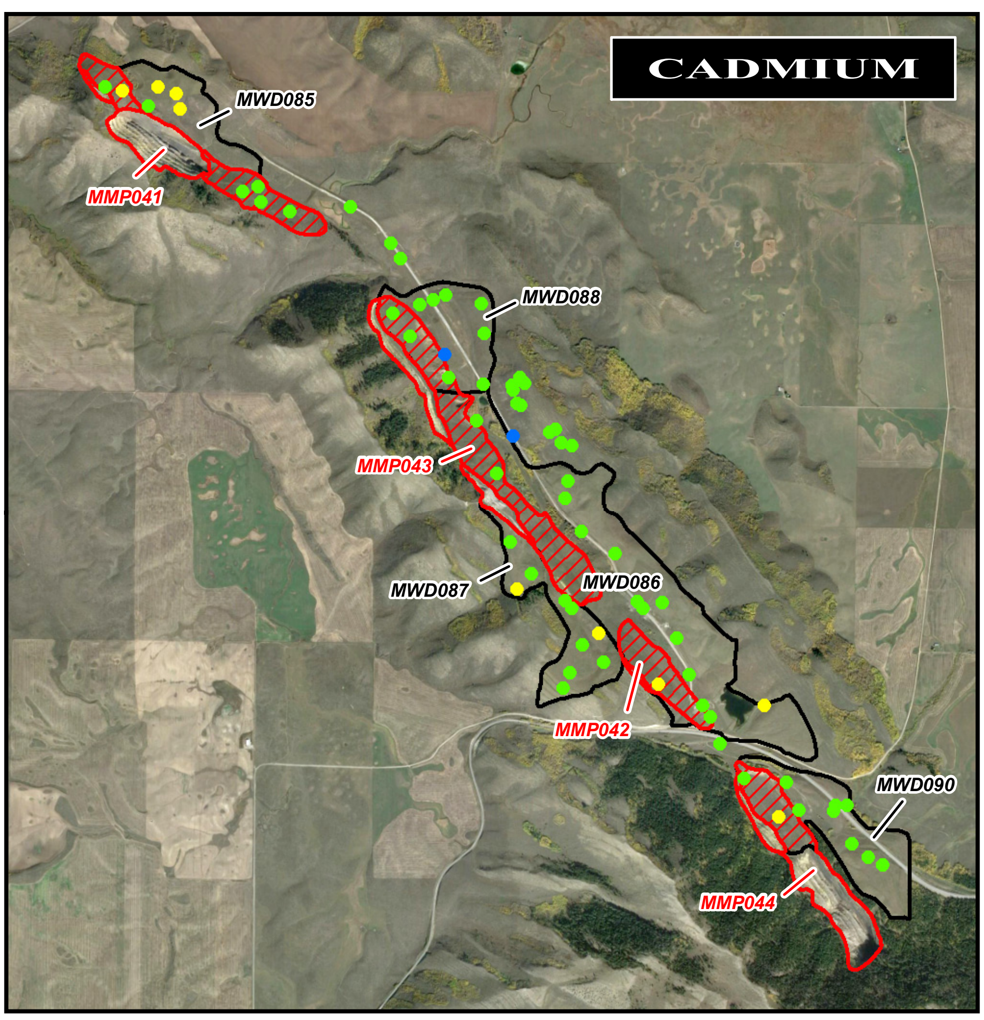


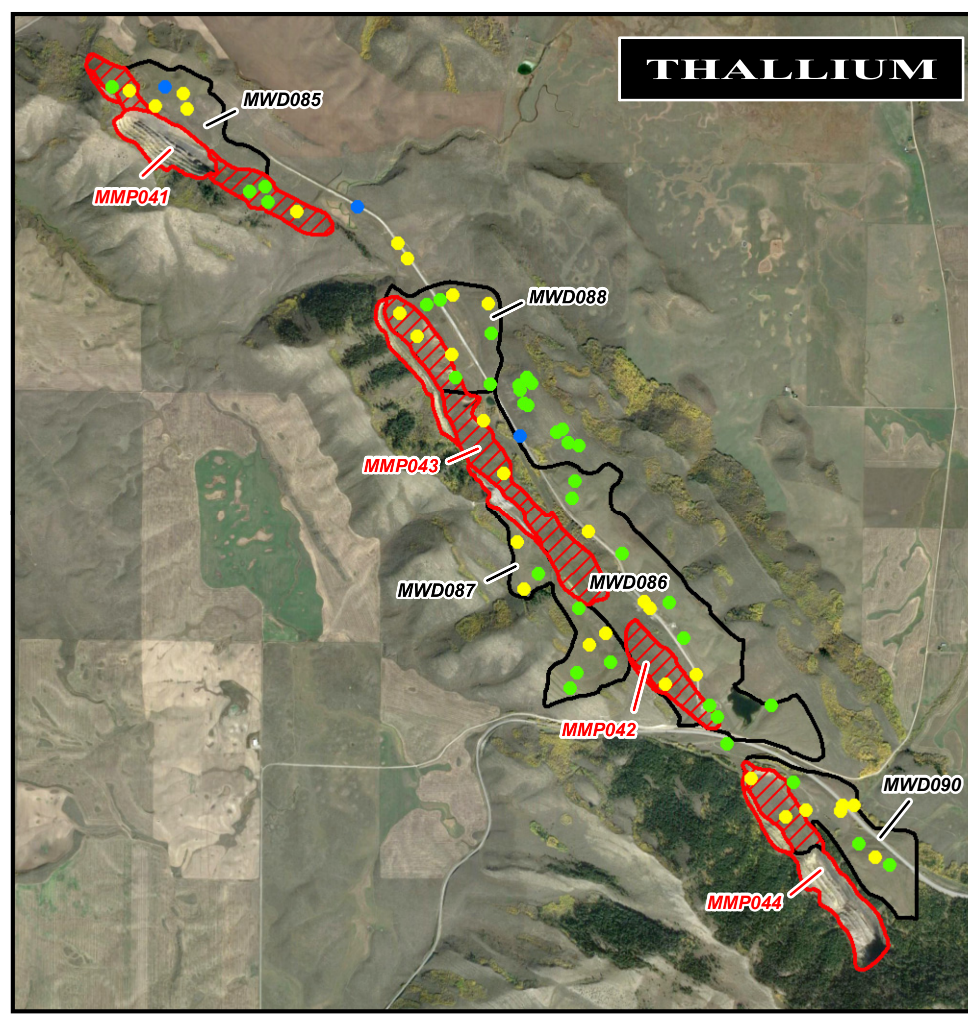
DRAWN BY D. Severson
6 Jun 2016
C:\Data\MWH\P4 Monsanto\HENRY_RI_Dec2015\FIGURES\Dwg 4-1_Henry Site_2004 and 2009 Upland Soil and Veg_Transect_6Jun2016.mxd

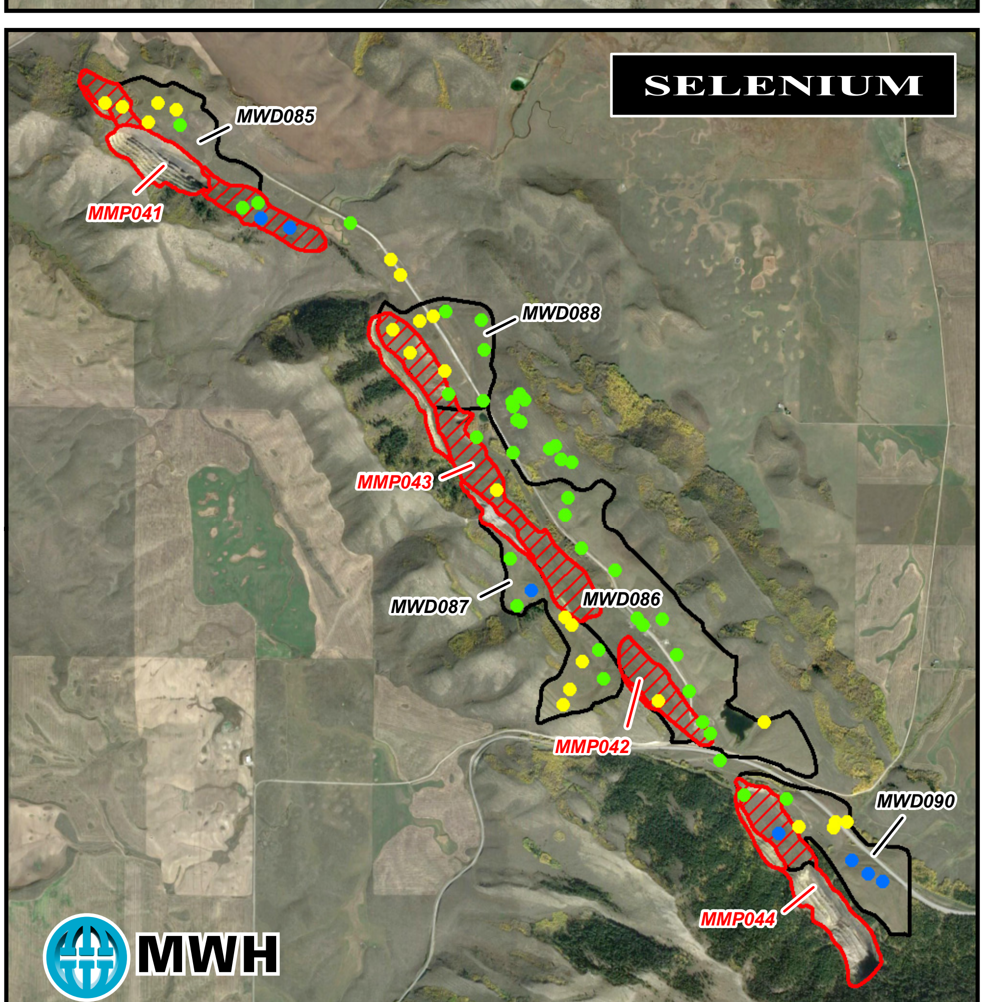
C:\Data\MWH\P4 Monsanto\HENRY_RI_Dec2015\FIGURES\Dwg 4-2_Henry Site_Upland Soil Analyte Conc Summary_25May2016.mxd 25 May 2016 DRAWN BY D. Severson











ARSENIC (mg/kg)
- <15.6 (background)
- 15.7 to 30.0
- 30.1 to 45.5

CADMIUM (mg/kg)
- <41.0 (background)
- 41.1 to 50
- 50.1 to 59.5

RADIUM-226 (pCi/g)
- <15.1 (background)
- 15.2 to 50.0
- >50.1 to 58.8

SELENIUM (mg/kg)
- <29.0 (background)
- 29.1 to 60.0
- 60.1 to 318

THALLIUM (mg/kg)
- <1.1 (background)
- 1.2 to 2.0
- 2.1 to 2.3

Mine pit location (approximate)

Backfilled

Waste rock dump location

pCi/g picoCuries per gram

mg/kg milligrams per kilogram

N W E S

0 2000 4000

Feet

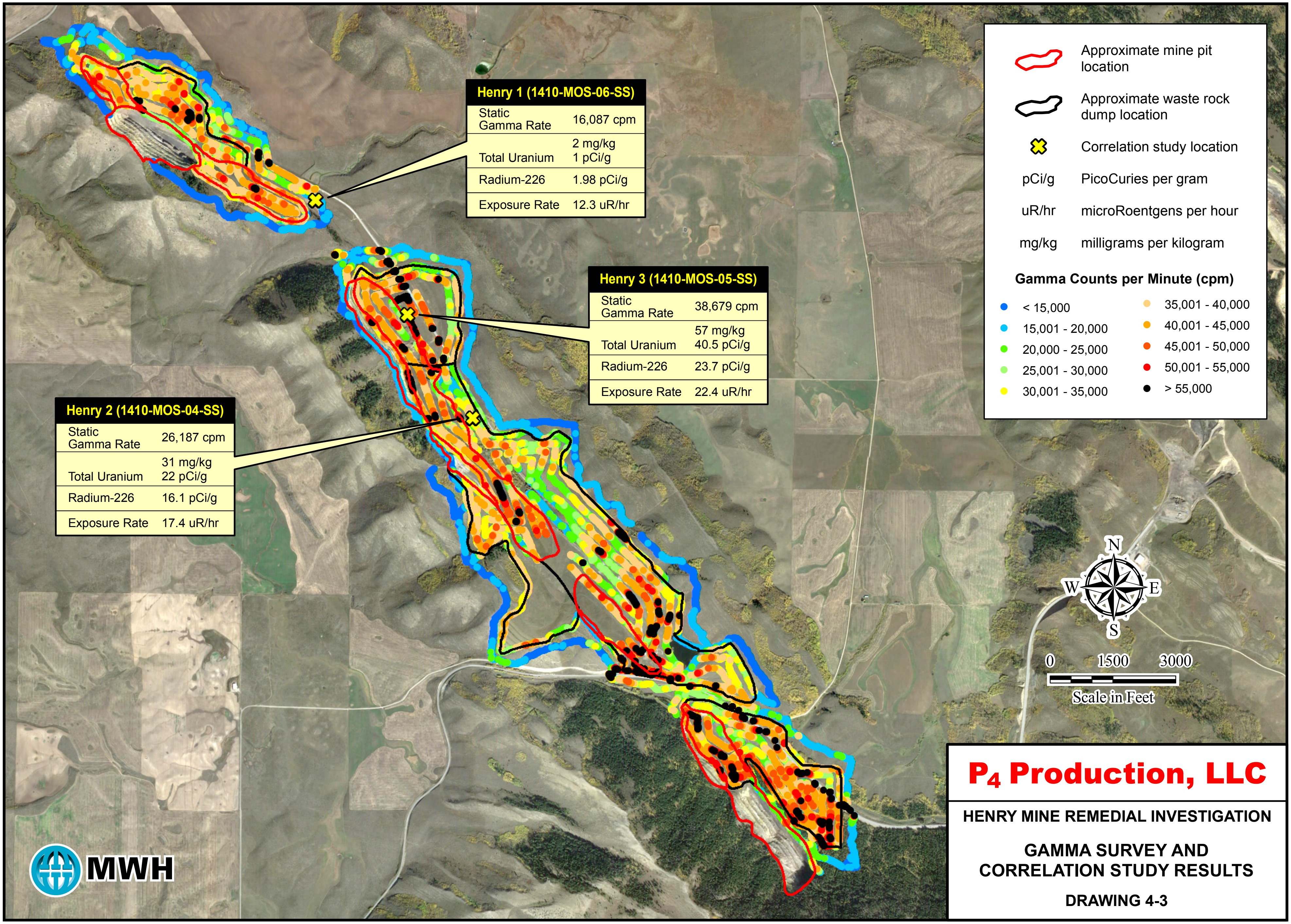
P_4 Production, LLC

HENRY MINE REMEDIAL INVESTIGATION

UPLAND SOIL ANALYTE CONCENTRATION SUMMARY

DRAWING 4-2

C:\Data\MWH\P4 Monsanto\HENRY_RI_Dec2015\FIGURES\Dwg 4-3_Henry Site_Gamma and Correlation Study_26May2016.mxd 26 May 2016 DRAWN BY D. Severson

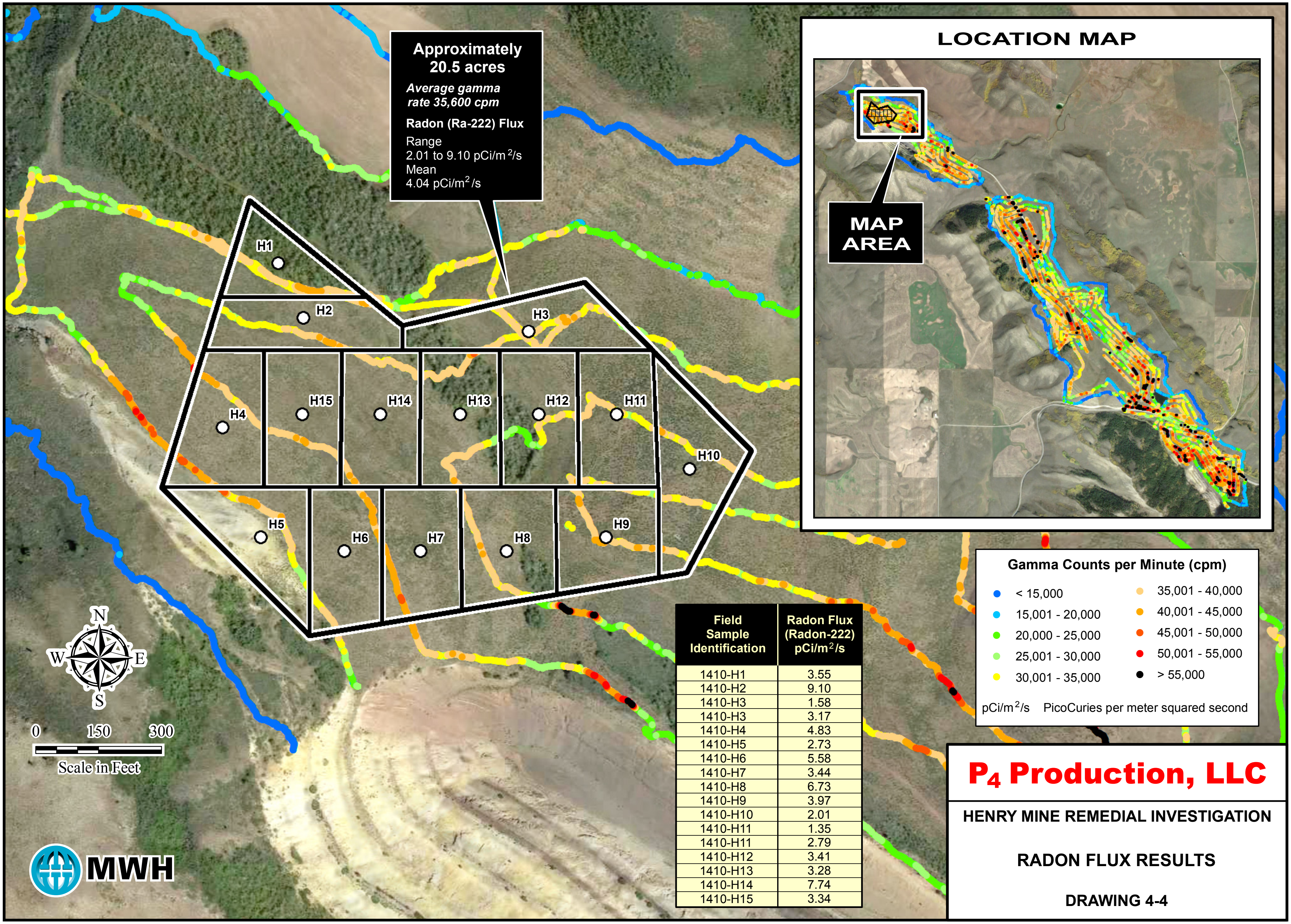


P$_4$ Production, LLC

HENRY MINE REMEDIAL INVESTIGATION

GAMMA SURVEY AND CORRELATION STUDY RESULTS

DRAWING 4-3



Field Sample Identification	Radon Flux (Radon-222) pCi/m^2/s
1410-H1	3.55
1410-H2	9.10
1410-H3	1.58
1410-H3	3.17
1410-H4	4.83
1410-H5	2.73
1410-H6	5.58
1410-H7	3.44
1410-H8	6.73
1410-H9	3.97
1410-H10	2.01
1410-H11	1.35
1410-H11	2.79
1410-H12	3.41
1410-H13	3.28
1410-H14	7.74
1410-H15	3.34

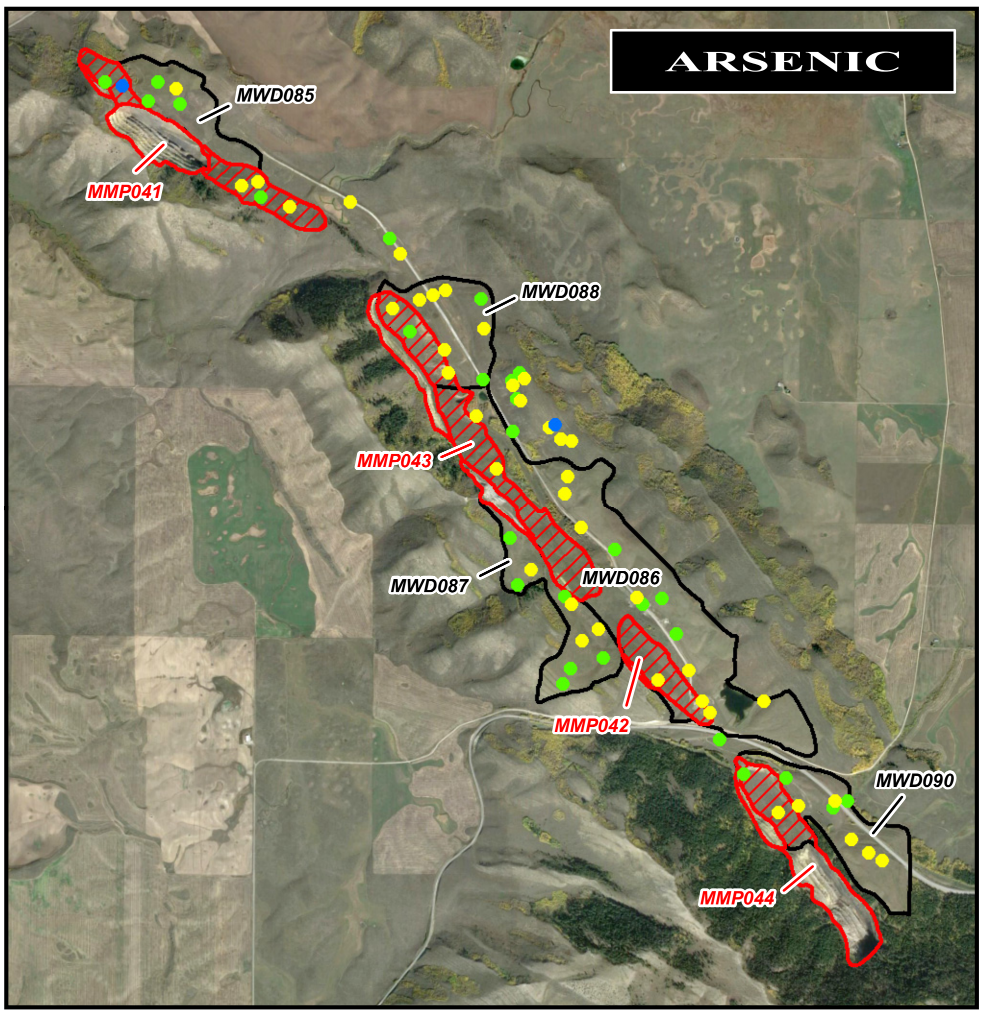
P_4 Production, LLC

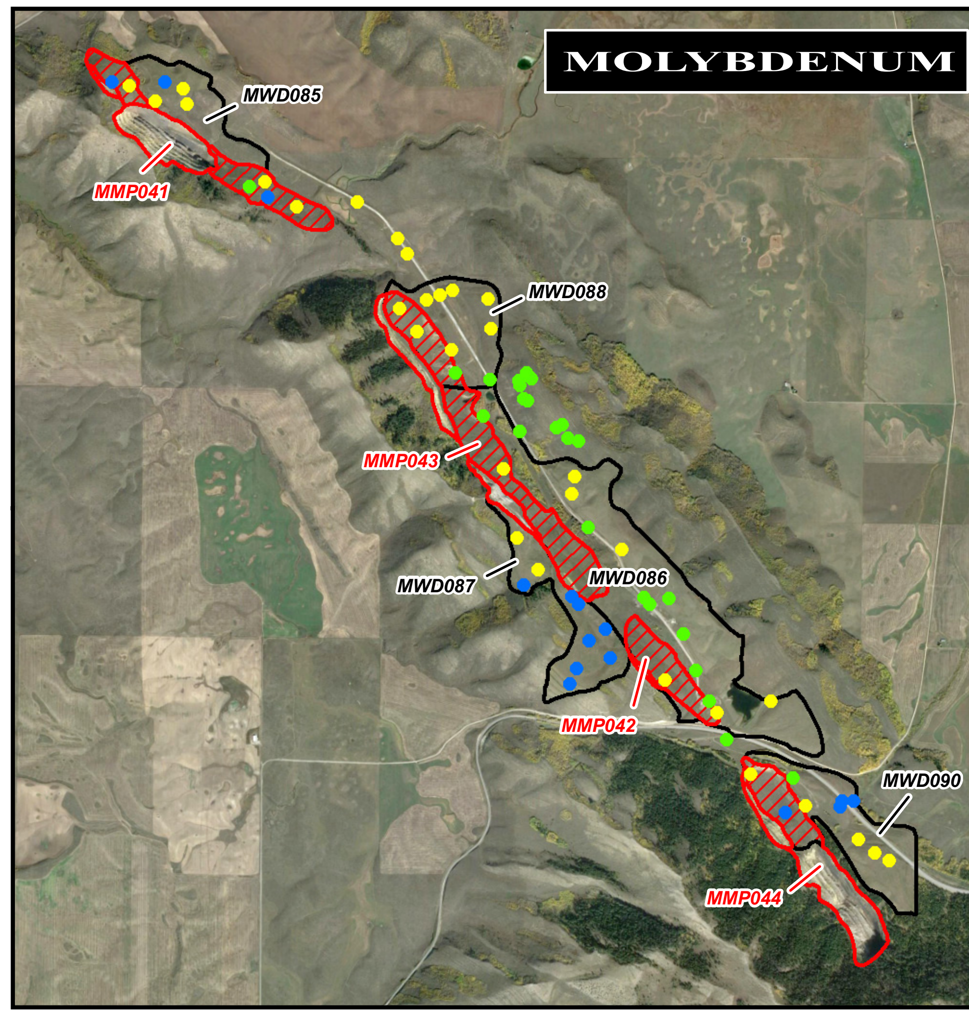
HENRY MINE REMEDIAL INVESTIGATION

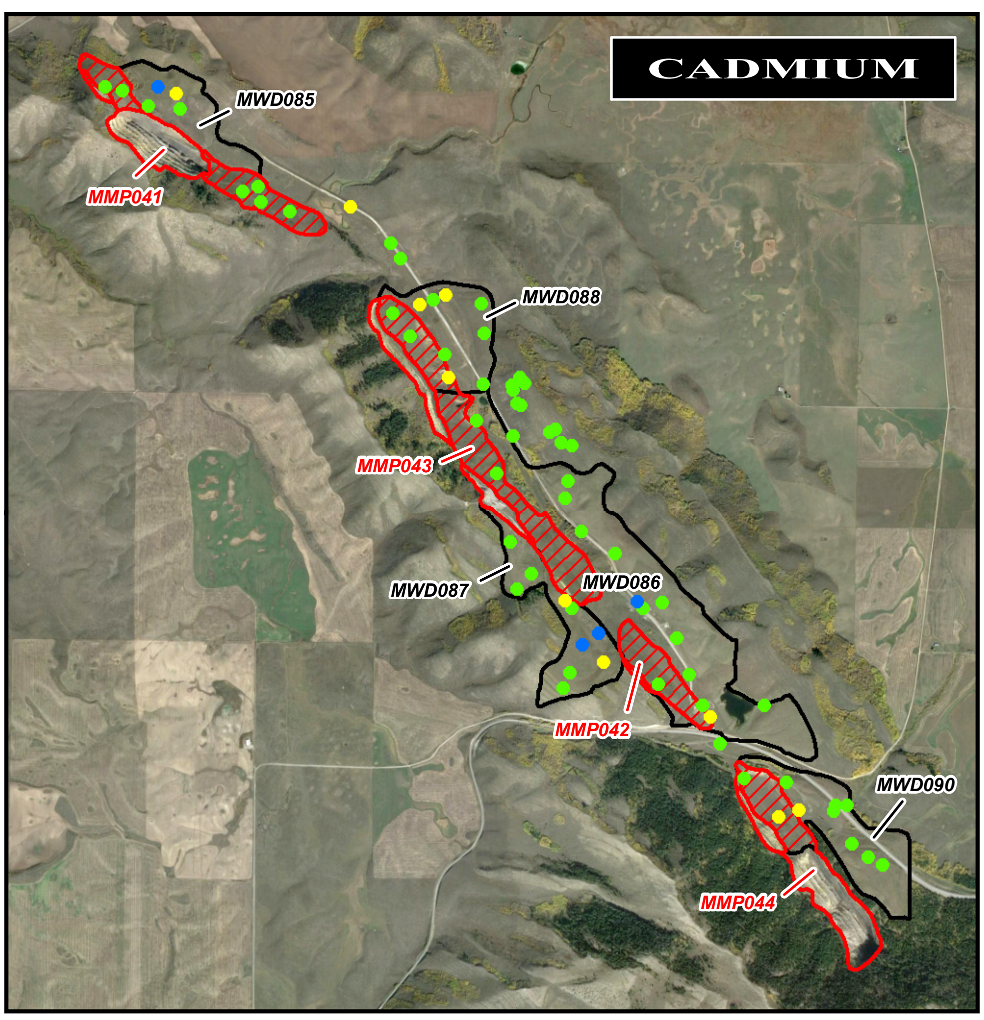
RADON FLUX RESULTS

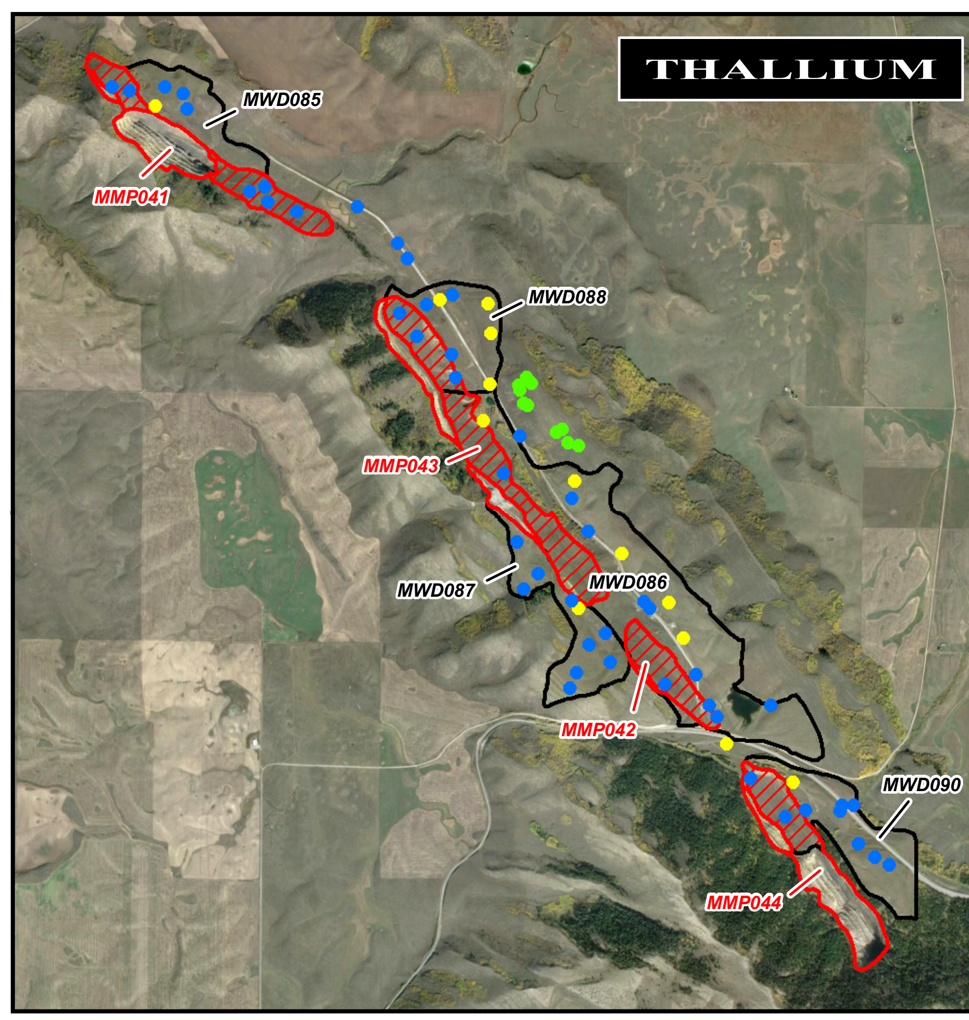
DRAWING 4-4

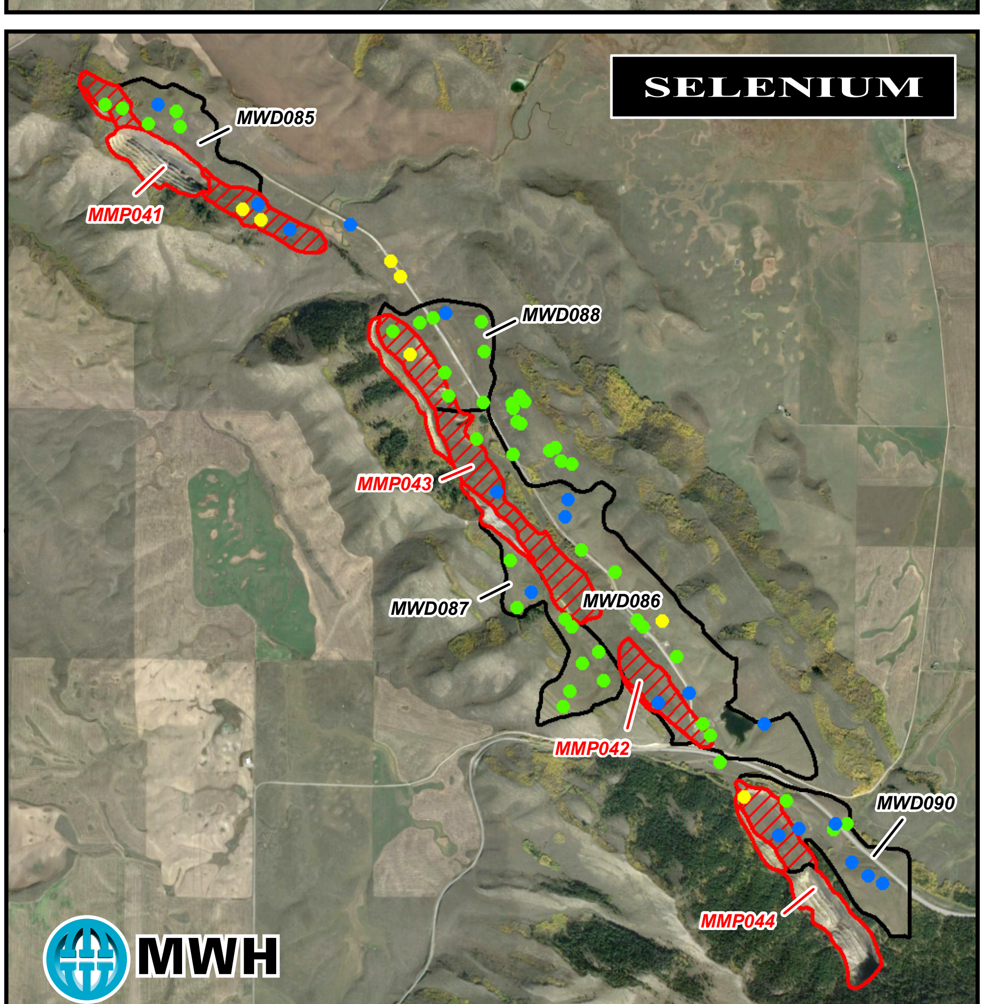
C:\Data\MWH\P4 Monsanto\HENRY_RI_Dec2015\FIGURES\Dwg 4-5_Henry Site_Upland Veg Grass and Forb Conc Summary_26May2016.mxd 26 May 2016 DRAWN BY D. Severson











ARSENIC (mg/kg)
- <0.1
- 0.2 to 5.0
- 5.1 to 10.2

CADMIUM (mg/kg)
- <1.7 (background)
- 1.8 to 3.5
- 3.6 to 5.3

SELENIUM (mg/kg)
- <3.4 (background)
- 3.5 to 5.0
- 5.1 to 150.0

MOLYBDENUM (mg/kg)
- <5.8 (background)
- 5.9 to 20.0
- 20.1 to 125

THALLIUM (mg/kg)
- <0.016 (background)
- 0.017 to 0.1
- 0.2 to 0.75

Mine pit location (approximate)

Backfilled

Waste rock dump location

mg/kg milligrams per kilogram

N W E S

0 2000 4000
Feet

P$_4$ Production, LLC

HENRY MINE REMEDIAL INVESTIGATION

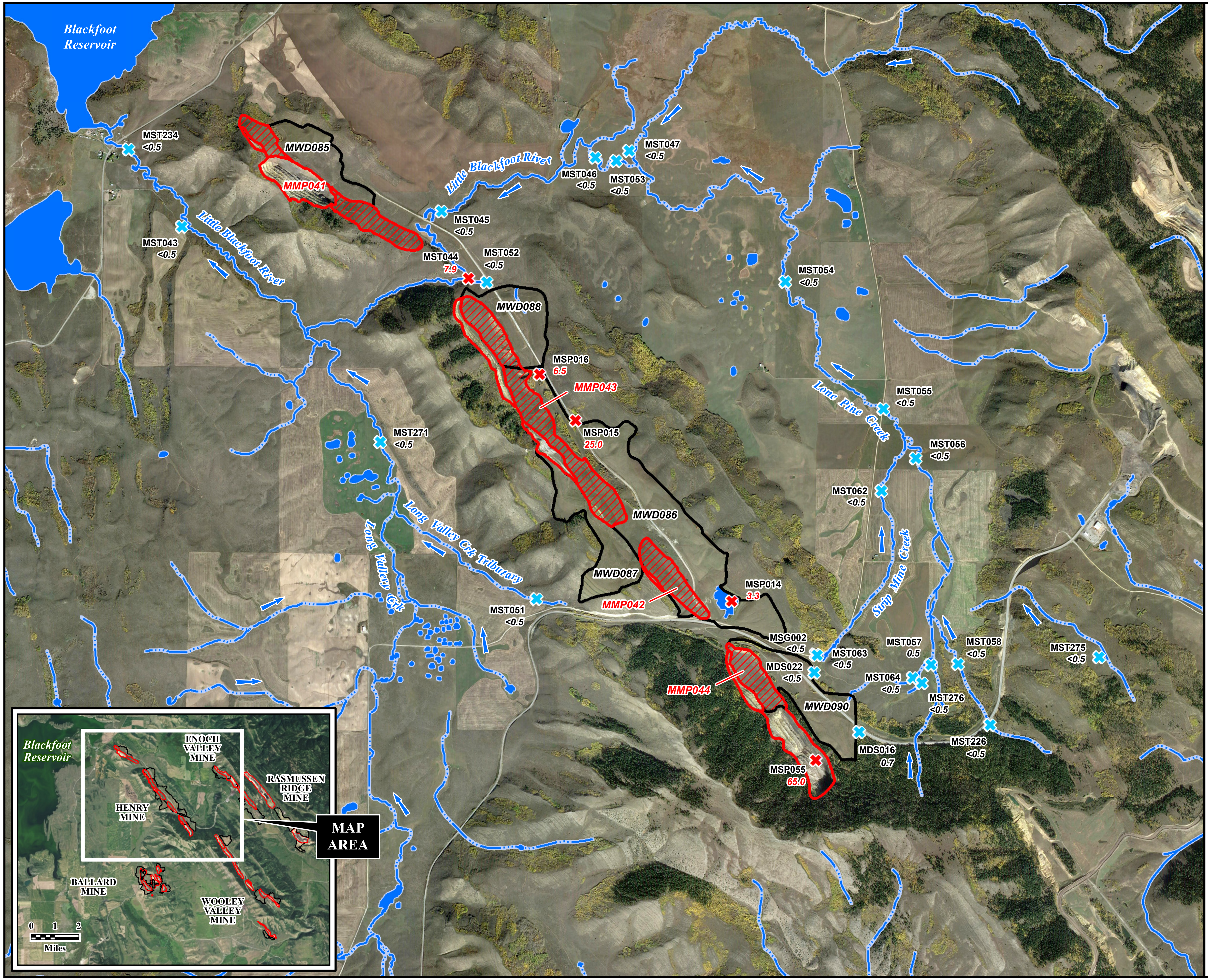
UPLAND VEGETATION GRASS AND FORB ANALYTE CONCENTRATION SUMMARY

DRAWING 4-5

DRAWN BY D. Severson

17 July 2017

C:\Data\MWH\P4 Monsanto\HENRY_RI_Dec2015\FIGURES\Dwg 4-6_Henry Site_Riparian Veg Locs and Results_17Jul2017.mxd



Mine pit location (approx)

Backfilled

Waste rock dump location

Riparian veg sample location not exceeding background limits

Riparian veg sample location exceeding background limits

Flow direction

ANALYTES

Se Selenium

NOTES

1. Data collected between 2004 and 2014.
2. All concentrations reported in milligrams per kilogram (mg/kg).
3. Values IN RED indicate background limit exceedance.
4. Selenium background value = 0.80 mg/kg.
5. Average Concentration (Avg) = Average of detected concentrations. If all results are non-detect, the maximum detection limit is shown.

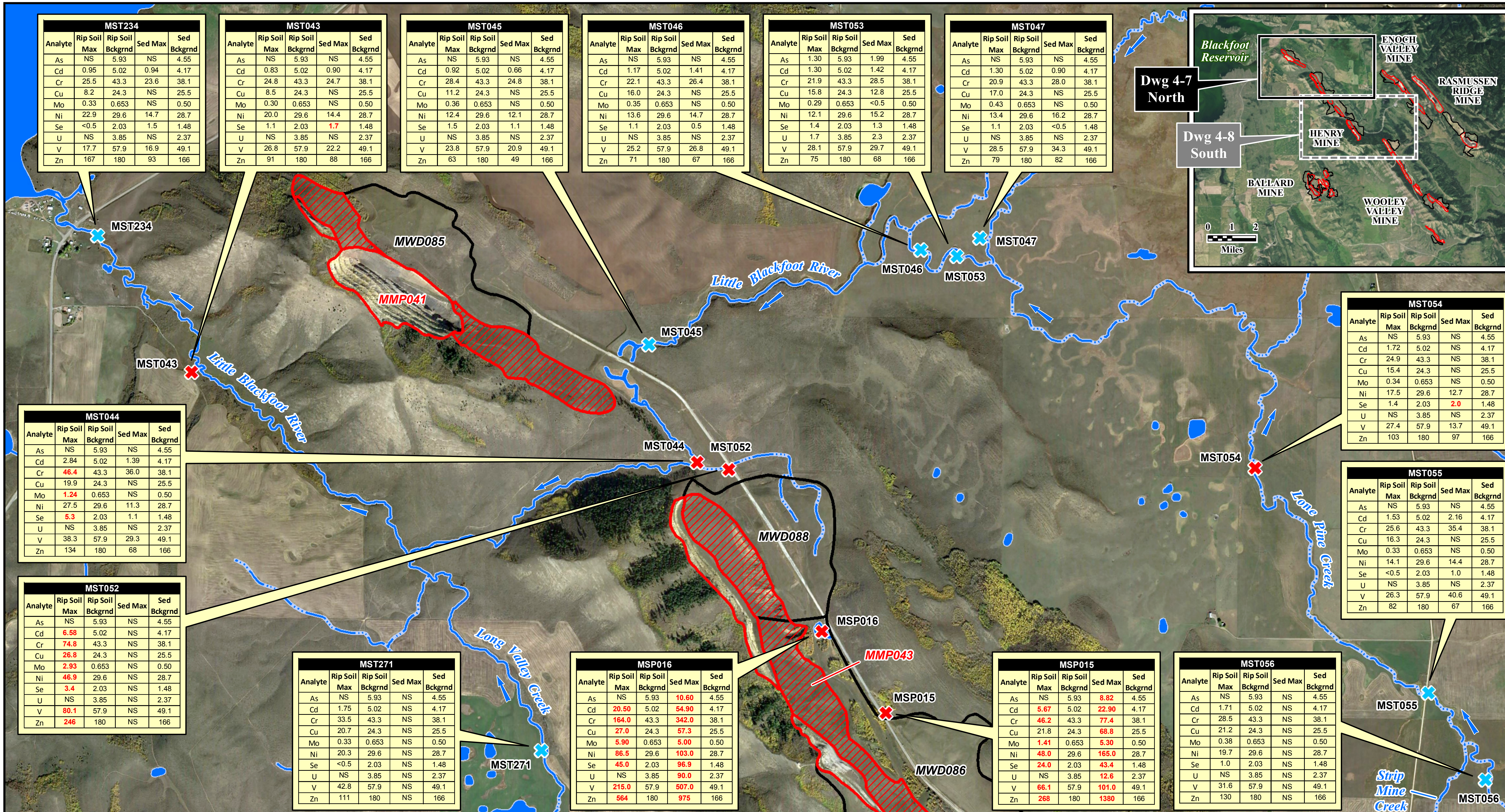
P_4 Production, LLC

HENRY MINE REMEDIAL INVESTIGATION

RIPARIAN VEGETATION LOCATIONS AND RESULTS

DRAWING 4-6

DRAWN BY D. Severson
6 Jul 2016
C:\Data\MWH\P4 Monsanto\HENRY_RI_Dec2015\FIGURES\Dwg 4-7_Henry Site North_Riparian Soil and Sed Locs and Results_6Jul2016.mxd



MST234

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	NS	5.93	NS	4.55
Cd	0.95	5.02	0.94	4.17
Cr	25.5	43.3	23.6	38.1
Cu	8.2	24.3	NS	25.5
Mo	0.33	0.653	NS	0.50
Ni	22.9	29.6	14.7	28.7
Se	<0.5	2.03	1.5	1.48
U	NS	3.85	NS	2.37
V	17.7	57.9	16.9	49.1
Zn	167	180	93	166

MST043

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	NS	5.93	NS	4.55
Cd	0.83	5.02	0.90	4.17
Cr	24.8	43.3	24.7	38.1
Cu	8.5	24.3	NS	25.5
Mo	0.30	0.653	NS	0.50
Ni	20.0	29.6	14.4	28.7
Se	1.1	2.03	1.7	1.48
U	NS	3.85	NS	2.37
V	26.8	57.9	22.2	49.1
Zn	91	180	88	166

MST045

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	NS	5.93	NS	4.55
Cd	0.92	5.02	0.66	4.17
Cr	28.4	43.3	24.8	38.1
Cu	11.2	24.3	NS	25.5
Mo	0.36	0.653	NS	0.50
Ni	12.4	29.6	12.1	28.7
Se	1.5	2.03	1.1	1.48
U	NS	3.85	NS	2.37
V	23.8	57.9	20.9	49.1
Zn	63	180	49	166

MST046

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	NS	5.93	NS	4.55
Cd	1.17	5.02	1.41	4.17
Cr	22.1	43.3	26.4	38.1
Cu	16.0	24.3	NS	25.5
Mo	0.35	0.653	NS	0.50
Ni	13.6	29.6	14.7	28.7
Se	1.1	2.03	0.5	1.48
U	NS	3.85	NS	2.37
V	25.2	57.9	26.8	49.1
Zn	71	180	67	166

MST053

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	1.30	5.93	1.99	4.55
Cd	1.30	5.02	1.42	4.17
Cr	21.9	43.3	28.5	38.1
Cu	15.8	24.3	12.8	25.5
Mo	0.29	0.653	<0.5	0.50
Ni	12.1	29.6	15.2	28.7
Se	1.4	2.03	1.3	1.48
U	1.7	3.85	2.3	2.37
V	28.1	57.9	29.7	49.1
Zn	75	180	68	166

MST047

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	NS	5.93	NS	4.55
Cd	1.30	5.02	0.90	4.17
Cr	20.9	43.3	28.0	38.1
Cu	17.0	24.3	NS	25.5
Mo	0.43	0.653	NS	0.50
Ni	13.4	29.6	16.2	28.7
Se	1.1	2.03	<0.5	1.48
U	NS	3.85	NS	2.37
V	28.5	57.9	34.3	49.1
Zn	79	180	82	166

MST044

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	NS	5.93	NS	4.55
Cd	2.84	5.02	1.39	4.17
Cr	46.4	43.3	36.0	38.1
Cu	19.9	24.3	NS	25.5
Mo	1.24	0.653	NS	0.50
Ni	27.5	29.6	11.3	28.7
Se	5.3	2.03	1.1	1.48
U	NS	3.85	NS	2.37
V	38.3	57.9	29.3	49.1
Zn	134	180	68	166

MST052

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	NS	5.93	NS	4.55
Cd	6.58	5.02	NS	4.17
Cr	74.8	43.3	NS	38.1
Cu	26.8	24.3	NS	25.5
Mo	2.93	0.653	NS	0.50
Ni	46.9	29.6	NS	28.7
Se	3.4	2.03	NS	1.48
U	NS	3.85	NS	2.37
V	80.1	57.9	NS	49.1
Zn	246	180	NS	166

MST054

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	NS	5.93	NS	4.55
Cd	1.72	5.02	NS	4.17
Cr	24.9	43.3	NS	38.1
Cu	15.4	24.3	NS	25.5
Mo	0.34	0.653	NS	0.50
Ni	17.5	29.6	12.7	28.7
Se	1.4	2.03	2.0	1.48
U	NS	3.85	NS	2.37
V	27.4	57.9	13.7	49.1
Zn	103	180	97	166

MST055

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	NS	5.93	NS	4.55
Cd	1.53	5.02	2.16	4.17
Cr	25.6	43.3	35.4	38.1
Cu	16.3	24.3	NS	25.5
Mo	0.33	0.653	NS	0.50
Ni	14.1	29.6	14.4	28.7
Se	<0.5	2.03	1.0	1.48
U	NS	3.85	NS	2.37
V	26.3	57.9	40.6	49.1
Zn	82	180	67	166

MST271

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	NS	5.93	NS	4.55
Cd	1.75	5.02	NS	4.17
Cr	33.5	43.3	NS	38.1
Cu	20.7	24.3	NS	25.5
Mo	0.33	0.653	NS	0.50
Ni	20.3	29.6	NS	28.7
Se	<0.5	2.03	NS	1.48
U	NS	3.85	NS	2.37
V	42.8	57.9	NS	49.1
Zn	111	180	NS	166

MSP016

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	NS	5.93	10.60	4.55
Cd	20.50	5.02	54.90	4.17
Cr	164.0	43.3	342.0	38.1
Cu	27.0	24.3	57.3	25.5
Mo	5.90	0.653	5.00	0.50
Ni	86.5	29.6	103.0	28.7
Se	45.0	2.03	96.9	1.48
U	NS	3.85	90.0	2.37
V	215.0	57.9	507.0	49.1
Zn	564	180	975	166

MSP015

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	NS	5.93	8.82	4.55
Cd	5.67	5.02	22.90	4.17
Cr	46.2	43.3	77.4	38.1
Cu	21.8	24.3	68.8	25.5
Mo	1.41	0.653	5.30	0.50
Ni	48.0	29.6	165.0	28.7
Se	24.0	2.03	43.4	1.48
U	NS	3.85	12.6	2.37
V	66.1	57.9	101.0	49.1
Zn	268	180	1380	166

MST056

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	NS	5.93	NS	4.55
Cd	1.71	5.02	NS	4.17
Cr	28.5	43.3	NS	38.1
Cu	21.2	24.3	NS	25.5
Mo	0.38	0.653	NS	0.50
Ni	19.7	29.6	NS	28.7
Se	1.0	2.03	NS	1.48
U	NS	3.85	NS	2.37
V	31.6	57.9	NS	49.1
Zn	130	180	NS	166

Mine pit location (approximate)
Backfilled
Waste rock dump location
Riparian soil/sediment sample not exceeding background limits
Riparian soil/sediment sample exceeding background limits
Flow direction

ANALYTES

As	Arsenic	Ni	Nickel
Cd	Cadmium	Se	Selenium
Cr	Chromium	U	Uranium
Cu	Copper	V	Vanadium
Mo	Molybdenum	Zn	Zinc

NOTES

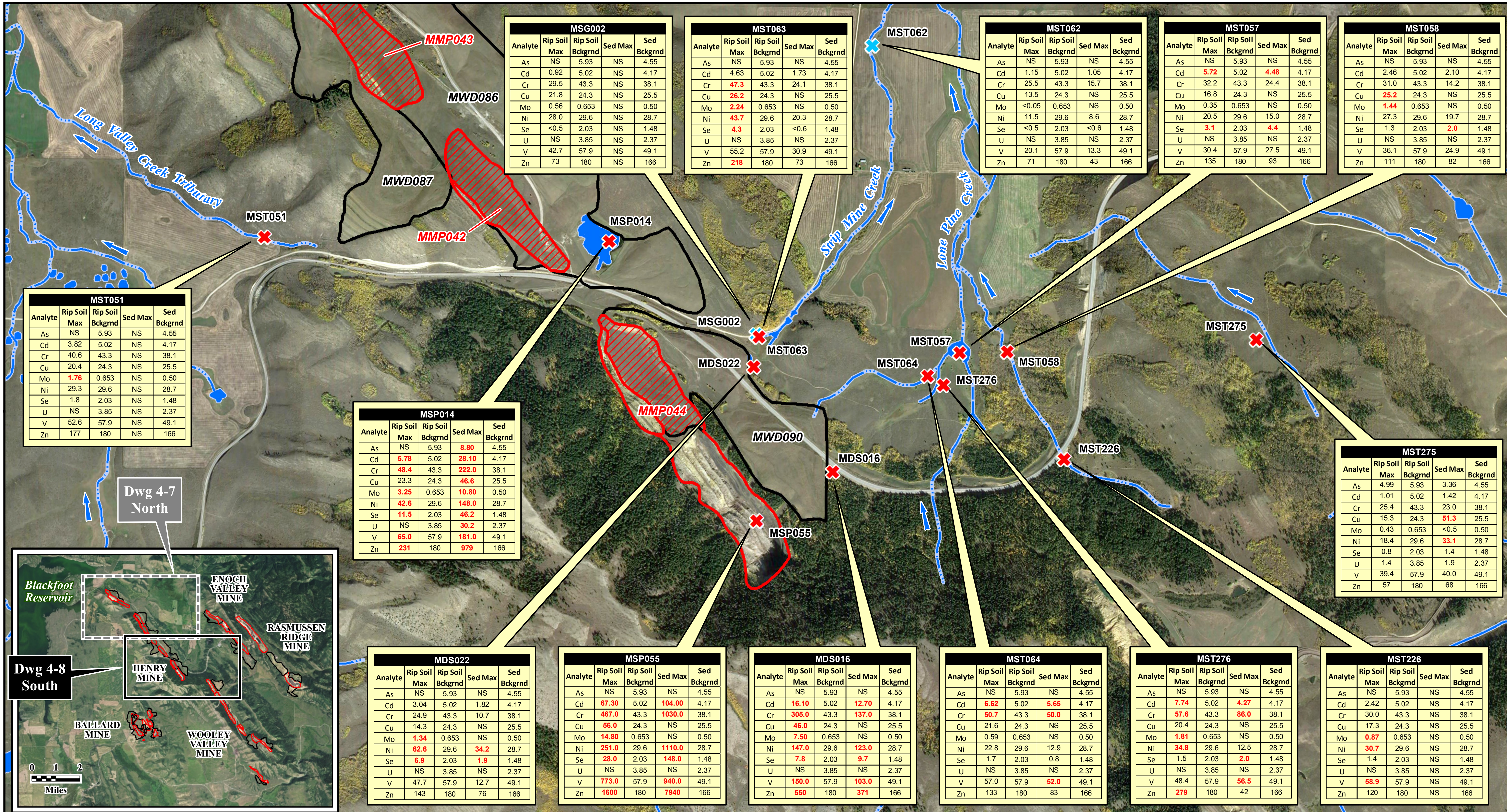
1. *2004 and 2010 data.*
2. *All concentrations reported in milligrams per kilogram (mg/kg).*
3. *Values* IN RED *indicate background limit exceedance.*

N E S W
0 800 1600
Feet

MWH

P_4 Production, LLC

HENRY MINE REMEDIAL INVESTIGATION
HENRY - NORTH
RIPARIAN SOIL AND SEDIMENT LOCATIONS AND RESULTS
DRAWING 4-7



MSG002

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	NS	5.93	NS	4.55
Cd	0.92	5.02	NS	4.17
Cr	29.5	43.3	NS	38.1
Cu	21.8	24.3	NS	25.5
Mo	0.56	0.653	NS	0.50
Ni	28.0	29.6	NS	28.7
Se	<0.5	2.03	NS	1.48
U	NS	3.85	NS	2.37
V	42.7	57.9	NS	49.1
Zn	73	180	NS	166

MST063

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	NS	5.93	NS	4.55
Cd	4.63	5.02	1.73	4.17
Cr	47.3	43.3	24.1	38.1
Cu	26.2	24.3	NS	25.5
Mo	2.24	0.653	NS	0.50
Ni	43.7	29.6	20.3	28.7
Se	4.3	2.03	<0.6	1.48
U	NS	3.85	NS	2.37
V	55.2	57.9	30.9	49.1
Zn	218	180	73	166

MST062

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	NS	5.93	NS	4.55
Cd	1.15	5.02	1.05	4.17
Cr	25.5	43.3	15.7	38.1
Cu	13.5	24.3	NS	25.5
Mo	<0.05	0.653	NS	0.50
Ni	11.5	29.6	8.6	28.7
Se	<0.5	2.03	<0.6	1.48
U	NS	3.85	NS	2.37
V	20.1	57.9	13.3	49.1
Zn	71	180	43	166

MST057

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	NS	5.93	NS	4.55
Cd	5.72	5.02	4.48	4.17
Cr	32.2	43.3	24.4	38.1
Cu	16.8	24.3	NS	25.5
Mo	0.35	0.653	NS	0.50
Ni	20.5	29.6	15.0	28.7
Se	3.1	2.03	4.4	1.48
U	NS	3.85	NS	2.37
V	30.4	57.9	27.5	49.1
Zn	135	180	93	166

MST058

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	NS	5.93	NS	4.55
Cd	2.46	5.02	2.10	4.17
Cr	31.0	43.3	14.2	38.1
Cu	25.2	24.3	NS	25.5
Mo	1.44	0.653	NS	0.50
Ni	27.3	29.6	19.7	28.7
Se	1.3	2.03	2.0	1.48
U	NS	3.85	NS	2.37
V	36.1	57.9	24.9	49.1
Zn	111	180	82	166

MST051

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	NS	5.93	NS	4.55
Cd	3.82	5.02	NS	4.17
Cr	40.6	43.3	NS	38.1
Cu	20.4	24.3	NS	25.5
Mo	1.76	0.653	NS	0.50
Ni	29.3	29.6	NS	28.7
Se	1.8	2.03	NS	1.48
U	NS	3.85	NS	2.37
V	52.6	57.9	NS	49.1
Zn	177	180	NS	166

MSP014

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	NS	5.93	8.80	4.55
Cd	5.78	5.02	28.10	4.17
Cr	48.4	43.3	222.0	38.1
Cu	23.3	24.3	46.6	25.5
Mo	3.25	0.653	10.80	0.50
Ni	42.6	29.6	148.0	28.7
Se	11.5	2.03	46.2	1.48
U	NS	3.85	30.2	2.37
V	65.0	57.9	181.0	49.1
Zn	231	180	979	166

MST275

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	4.99	5.93	3.36	4.55
Cd	1.01	5.02	1.42	4.17
Cr	25.4	43.3	23.0	38.1
Cu	15.3	24.3	51.3	25.5
Mo	0.43	0.653	<0.5	0.50
Ni	18.4	29.6	33.1	28.7
Se	0.8	2.03	1.4	1.48
U	1.4	3.85	1.9	2.37
V	39.4	57.9	40.0	49.1
Zn	57	180	68	166

MDS022

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	NS	5.93	NS	4.55
Cd	3.04	5.02	1.82	4.17
Cr	24.9	43.3	10.7	38.1
Cu	14.3	24.3	NS	25.5
Mo	1.34	0.653	NS	0.50
Ni	62.6	29.6	34.2	28.7
Se	6.9	2.03	1.9	1.48
U	NS	3.85	NS	2.37
V	47.7	57.9	12.7	49.1
Zn	143	180	76	166

MSP055

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	NS	5.93	NS	4.55
Cd	67.30	5.02	104.00	4.17
Cr	467.0	43.3	1030.0	38.1
Cu	56.0	24.3	NS	25.5
Mo	14.80	0.653	NS	0.50
Ni	251.0	29.6	1110.0	28.7
Se	28.0	2.03	148.0	1.48
U	NS	3.85	NS	2.37
V	773.0	57.9	940.0	49.1
Zn	1600	180	7940	166

MDS016

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	NS	5.93	NS	4.55
Cd	16.10	5.02	12.70	4.17
Cr	305.0	43.3	137.0	38.1
Cu	46.0	24.3	NS	25.5
Mo	7.50	0.653	NS	0.50
Ni	147.0	29.6	123.0	28.7
Se	7.8	2.03	9.7	1.48
U	NS	3.85	NS	2.37
V	150.0	57.9	103.0	49.1
Zn	550	180	371	166

MST064

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	NS	5.93	NS	4.55
Cd	6.62	5.02	5.65	4.17
Cr	50.7	43.3	50.0	38.1
Cu	21.6	24.3	NS	25.5
Mo	0.59	0.653	NS	0.50
Ni	22.8	29.6	12.9	28.7
Se	1.7	2.03	0.8	1.48
U	NS	3.85	NS	2.37
V	57.0	57.9	52.0	49.1
Zn	133	180	83	166

MST276

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	NS	5.93	NS	4.55
Cd	7.74	5.02	4.27	4.17
Cr	57.6	43.3	86.0	38.1
Cu	20.4	24.3	NS	25.5
Mo	1.81	0.653	NS	0.50
Ni	34.8	29.6	12.5	28.7
Se	1.5	2.03	2.0	1.48
U	NS	3.85	NS	2.37
V	48.4	57.9	56.5	49.1
Zn	279	180	42	166

MST226

Analyte	Rip Soil Max	Rip Soil Bckgrnd	Sed Max	Sed Bckgrnd
As	NS	5.93	NS	4.55
Cd	2.42	5.02	NS	4.17
Cr	30.0	43.3	NS	38.1
Cu	17.3	24.3	NS	25.5
Mo	0.87	0.653	NS	0.50
Ni	30.7	29.6	NS	28.7
Se	1.4	2.03	NS	1.48
U	NS	3.85	NS	2.37
V	58.9	57.9	NS	49.1
Zn	120	180	NS	166

Mine pit location (approximate)
Backfilled
Waste rock dump location
Riparian soil/sediment sample not exceeding background limits
Riparian soil/sediment sample exceeding background limits
Flow direction

ANALYTES

As	Arsenic	Ni	Nickel
Cd	Cadmium	Se	Selenium
Cr	Chromium	U	Uranium
Cu	Copper	V	Vanadium
Mo	Molybdenum	Zn	Zinc

NOTES

1. *2004 and 2010 data.*
2. *All concentrations reported in milligrams per kilogram (mg/kg).*
3. *Values IN RED indicate background limit exceedance.*

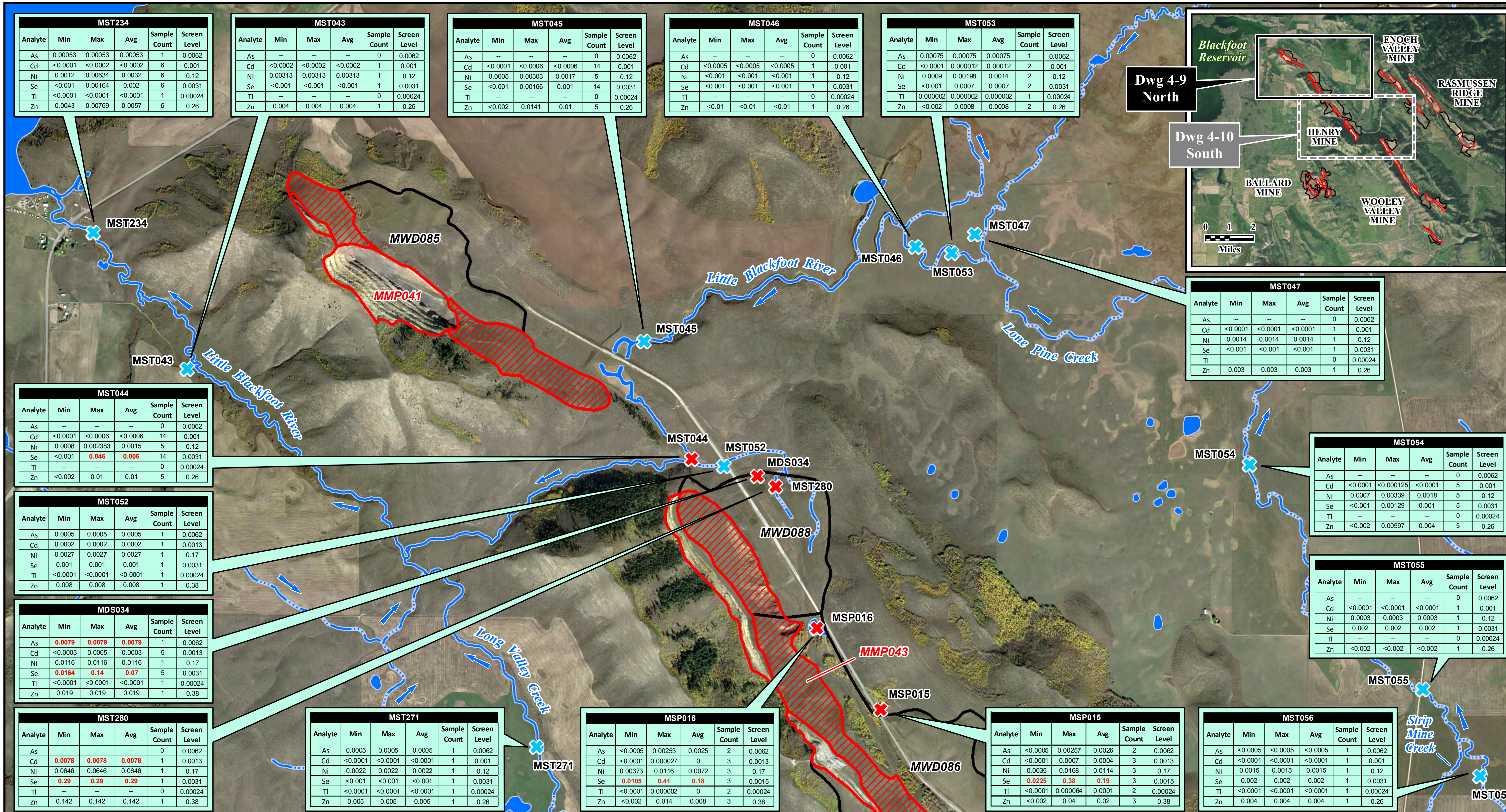
N
W E
S
0 800 1600
Feet

MWH

P4 Production, LLC

HENRY MINE REMEDIAL INVESTIGATION
HENRY - SOUTH
RIPARIAN SOIL AND SEDIMENT LOCATIONS AND RESULTS
DRAWING 4-8

DRAWN BY D. Severson
17 July 2017
C:\Data\MWH\P4 Monsanto\HENRY_RI_Dec2015\FIGURES\Dwg 4-8_Henry Site South_Riparian Soil and Sed Locs and Results_17Jul2017.mxd



MST234

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	0.00053	0.00053	0.00053	1	0.0062
Cd	<0.0001	<0.0002	<0.0002	6	0.001
Ni	0.0012	0.00634	0.0032	6	0.12
Se	<0.001	0.00164	0.002	6	0.0031
Tl	<0.0001	<0.0001	<0.0001	1	0.00024
Zn	0.0043	0.00769	0.0057	6	0.26

MST043

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	--	--	--	0	0.0062
Cd	<0.0002	<0.0002	<0.0002	1	0.001
Ni	0.00313	0.00313	0.00313	1	0.12
Se	<0.001	<0.001	<0.001	1	0.0031
Tl	--	--	--	0	0.00024
Zn	0.004	0.004	0.004	1	0.26

MST045

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	--	--	--	0	0.0062
Cd	<0.0001	<0.0006	<0.0006	14	0.001
Ni	0.0005	0.00303	0.0017	5	0.12
Se	<0.001	0.00166	0.001	14	0.0031
Tl	--	--	--	0	0.00024
Zn	<0.002	0.0141	0.01	5	0.26

MST046

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	--	--	--	0	0.0062
Cd	<0.0005	<0.0005	<0.0005	1	0.001
Ni	<0.001	<0.001	<0.001	1	0.12
Se	<0.001	<0.001	<0.001	1	0.0031
Tl	--	--	--	0	0.00024
Zn	<0.01	<0.01	<0.01	1	0.26

MST053

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	0.00075	0.00075	0.00075	1	0.0062
Cd	<0.0001	0.000012	0.00012	2	0.001
Ni	0.0009	0.00198	0.0014	2	0.12
Se	<0.001	0.0007	0.0007	2	0.0031
Tl	0.000002	0.000002	0.000002	1	0.00024
Zn	<0.002	0.0008	0.0008	2	0.26

MST047

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	--	--	--	0	0.0062
Cd	<0.0001	<0.0001	<0.0001	1	0.001
Ni	0.0014	0.0014	0.0014	1	0.12
Se	<0.001	<0.001	<0.001	1	0.0031
Tl	--	--	--	0	0.00024
Zn	0.003	0.003	0.003	1	0.26

MST044

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	--	--	--	0	0.0062
Cd	<0.0001	<0.0006	<0.0006	14	0.001
Ni	0.0008	0.002383	0.0015	5	0.12
Se	<0.001	0.046	0.006	14	0.0031
Tl	--	--	--	0	0.00024
Zn	<0.002	0.01	0.01	5	0.26

MST054

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	--	--	--	0	0.0062
Cd	<0.0001	<0.000125	<0.0001	5	0.001
Ni	0.0007	0.00339	0.0018	5	0.12
Se	<0.001	0.00129	0.001	5	0.0031
Tl	--	--	--	0	0.00024
Zn	<0.002	0.00597	0.004	5	0.26

MST052

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	0.0005	0.0005	0.0005	1	0.0062
Cd	0.0002	0.0002	0.0002	1	0.0013
Ni	0.0027	0.0027	0.0027	1	0.17
Se	0.001	0.001	0.001	1	0.0031
Tl	<0.0001	<0.0001	<0.0001	1	0.00024
Zn	0.008	0.008	0.008	1	0.38

MST055

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	--	--	--	0	0.0062
Cd	<0.0001	<0.0001	<0.0001	1	0.001
Ni	0.0003	0.0003	0.0003	1	0.12
Se	0.002	0.002	0.002	1	0.0031
Tl	--	--	--	0	0.00024
Zn	<0.002	<0.002	<0.002	1	0.26

MDS034

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	0.0079	0.0079	0.0079	1	0.0062
Cd	<0.0003	0.0005	0.0003	5	0.0013
Ni	0.0116	0.0116	0.0116	1	0.17
Se	0.0164	0.14	0.07	5	0.0031
Tl	<0.0001	<0.0001	<0.0001	1	0.00024
Zn	0.019	0.019	0.019	1	0.38

MST280

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	--	--	--	0	0.0062
Cd	0.0078	0.0078	0.0078	1	0.0013
Ni	0.0646	0.0646	0.0646	1	0.17
Se	0.29	0.29	0.29	1	0.0031
Tl	--	--	--	0	0.00024
Zn	0.142	0.142	0.142	1	0.38

MST271

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	0.0005	0.0005	0.0005	1	0.0062
Cd	<0.0001	<0.0001	<0.0001	1	0.001
Ni	0.0022	0.0022	0.0022	1	0.12
Se	<0.001	<0.001	<0.001	1	0.0031
Tl	<0.0001	<0.0001	<0.0001	1	0.00024
Zn	0.005	0.005	0.005	1	0.26

MSP016

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	<0.0005	0.00253	0.0025	2	0.0062
Cd	<0.0001	0.000027	0	3	0.0013
Ni	0.00373	0.0116	0.0072	3	0.17
Se	0.0105	0.41	0.18	3	0.0015
Tl	<0.0001	0.000002	0	2	0.00024
Zn	<0.002	0.014	0.008	3	0.38

MSP015

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	<0.0005	0.00257	0.0026	2	0.0062
Cd	<0.0001	0.0007	0.0004	3	0.0013
Ni	0.0035	0.0168	0.0114	3	0.17
Se	0.0225	0.38	0.19	3	0.0015
Tl	<0.0001	0.000064	0.0001	2	0.00024
Zn	<0.002	0.04	0.02	3	0.38

MST056

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	<0.0005	<0.0005	<0.0005	1	0.0062
Cd	<0.0001	<0.0001	<0.0001	1	0.001
Ni	0.0015	0.0015	0.0015	1	0.12
Se	0.002	0.002	0.002	1	0.0031
Tl	<0.0001	<0.0001	<0.0001	1	0.00024
Zn	0.004	0.004	0.004	1	0.26

Mine pit location (approximate)

Backfilled

Waste rock dump location

Surface water sample location not exceeding screening level

Surface water sample location exceeding screening level

Flow direction

As	Arsenic
Cd	Cadmium
Ni	Nickel
Se	Selenium
Tl	Thallium
Zn	Zinc

1. *Data collected between 2004 and 2014.*
2. *All concentrations reported in milligrams per liter (mg/l).*
3. *Dissolved (filtered) concentrations reported for all analytes except for selenium, where total (unfiltered) concentrations are reported.*
4. *Values* IN RED *indicate screening level exceedance.*
5. *Average Concentration (Avg) = Average of detected concentrations. If all results are non-detect, the maximum detection limit is shown.*

N W E S

0 800 1600

Feet

MWH

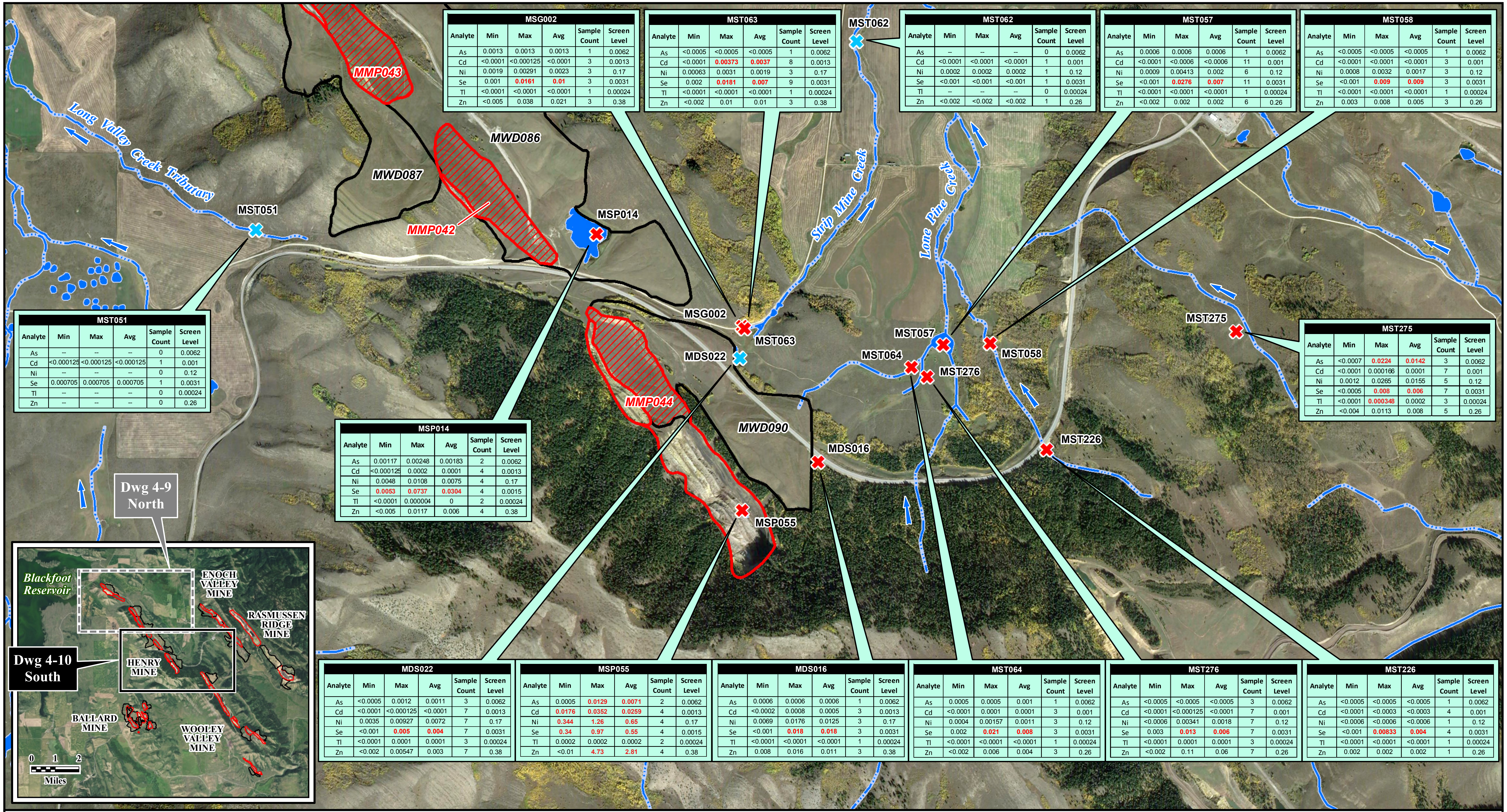
P_4 Production, LLC

HENRY MINE REMEDIAL INVESTIGATION
HENRY - NORTH
SURFACE WATER LOCATIONS AND RESULTS
DRAWING 4-9

DRAWN BY D. Severson

10 Apr 2017

C:\Data\MWH\P4 Monsanto\HENRY_RI_Dec2015\FIGURES\Dwg 4-9_Henry Site North_SW Locs and Results_10Apr2017.mxd



MSG002

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	0.0013	0.0013	0.0013	1	0.0062
Cd	<0.0001	<0.000125	<0.0001	3	0.0013
Ni	0.0019	0.00291	0.0023	3	0.17
Se	0.001	0.0161	0.01	3	0.0031
Tl	<0.0001	<0.0001	<0.0001	1	0.00024
Zn	<0.005	0.038	0.021	3	0.38

MST063

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	<0.0005	<0.0005	<0.0005	1	0.0062
Cd	<0.0001	0.00373	0.0037	8	0.0013
Ni	0.00063	0.0031	0.0019	3	0.17
Se	0.002	0.0181	0.007	9	0.0031
Tl	<0.0001	<0.0001	<0.0001	1	0.00024
Zn	<0.002	0.01	0.01	3	0.38

MST062

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	--	--	--	0	0.0062
Cd	<0.0001	<0.0001	<0.0001	1	0.001
Ni	0.0002	0.0002	0.0002	1	0.12
Se	<0.001	<0.001	<0.001	1	0.0031
Tl	--	--	--	0	0.00024
Zn	<0.002	<0.002	<0.002	1	0.26

MST057

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	0.0006	0.0006	0.0006	1	0.0062
Cd	<0.0001	<0.0006	<0.0006	11	0.001
Ni	0.0009	0.00413	0.002	6	0.12
Se	<0.001	0.0276	0.007	11	0.0031
Tl	<0.0001	<0.0001	<0.0001	1	0.00024
Zn	<0.002	0.002	0.002	6	0.26

MST058

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	<0.0005	<0.0005	<0.0005	1	0.0062
Cd	<0.0001	<0.0001	<0.0001	3	0.001
Ni	0.0008	0.0032	0.0017	3	0.12
Se	<0.001	0.009	0.009	3	0.0031
Tl	<0.0001	<0.0001	<0.0001	1	0.00024
Zn	0.003	0.008	0.005	3	0.26

MST051

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	--	--	--	0	0.0062
Cd	<0.000125	<0.000125	<0.000125	1	0.001
Ni	--	--	--	0	0.12
Se	0.000705	0.000705	0.000705	1	0.0031
Tl	--	--	--	0	0.00024
Zn	--	--	--	0	0.26

MSP014

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	0.00117	0.00248	0.00183	2	0.0062
Cd	<0.000125	0.0002	0.0001	4	0.0013
Ni	0.0048	0.0108	0.0075	4	0.17
Se	0.0053	0.0737	0.0304	4	0.0015
Tl	<0.0001	0.000004	0	2	0.00024
Zn	<0.005	0.0117	0.006	4	0.38

MST275

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	<0.0007	0.0224	0.0142	3	0.0062
Cd	<0.0001	0.000166	0.0001	7	0.001
Ni	0.0012	0.0265	0.0155	5	0.12
Se	<0.0005	0.008	0.006	7	0.0031
Tl	<0.0001	0.000348	0.0002	3	0.00024
Zn	<0.004	0.0113	0.008	5	0.26

MDS022

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	<0.0005	0.0012	0.0011	3	0.0062
Cd	<0.0001	<0.000125	<0.0001	7	0.0013
Ni	0.0035	0.00927	0.0072	7	0.17
Se	<0.001	0.005	0.004	7	0.0031
Tl	<0.0001	0.0001	0.0001	3	0.00024
Zn	<0.002	0.00547	0.003	7	0.38

MSP055

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	0.0005	0.0129	0.0071	2	0.0062
Cd	0.0176	0.0352	0.0259	4	0.0013
Ni	0.344	1.26	0.65	4	0.17
Se	0.34	0.97	0.55	4	0.0015
Tl	0.0002	0.0002	0.0002	2	0.00024
Zn	<0.01	4.73	2.81	4	0.38

MDS016

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	0.0006	0.0006	0.0006	1	0.0062
Cd	<0.0002	0.0008	0.0005	3	0.0013
Ni	0.0069	0.0176	0.0125	3	0.17
Se	<0.001	0.018	0.018	3	0.0031
Tl	<0.0001	<0.0001	<0.0001	1	0.00024
Zn	0.008	0.016	0.011	3	0.38

MST064

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	0.0005	0.0005	0.001	1	0.0062
Cd	<0.0001	0.0001	0.0001	3	0.001
Ni	0.0004	0.00157	0.0011	3	0.12
Se	0.002	0.021	0.008	3	0.0031
Tl	<0.0001	<0.0001	<0.0001	1	0.00024
Zn	<0.002	0.006	0.004	3	0.26

MST276

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	<0.0005	<0.0005	<0.0005	3	0.0062
Cd	<0.0001	<0.000125	<0.0001	7	0.001
Ni	<0.0006	0.00341	0.0018	7	0.12
Se	0.003	0.013	0.006	7	0.0031
Tl	<0.0001	0.0001	0.0001	3	0.00024
Zn	<0.002	0.11	0.06	7	0.26

MST226

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	<0.0005	<0.0005	<0.0005	1	0.0062
Cd	<0.0001	<0.0003	<0.0003	4	0.001
Ni	<0.0006	<0.0006	<0.0006	1	0.12
Se	<0.001	0.00833	0.004	4	0.0031
Tl	<0.0001	<0.0001	<0.0001	1	0.00024
Zn	0.002	0.002	0.002	1	0.26

Mine pit location (approximate)
Backfilled
Waste rock dump location
Surface water sample location not exceeding screening level
Surface water sample location exceeding screening level
Flow direction

As	Arsenic
Cd	Cadmium
Ni	Nickel
Se	Selenium
Tl	Thallium
Zn	Zinc

1. *Data collected between 2004 and 2014.*
2. *All concentrations reported in milligrams per liter (mg/l).*
3. *Dissolved (filtered) concentrations reported for all analytes except for selenium, where total (unfiltered) concentrations are reported.*
4. *Values IN RED indicate screening level exceedance.*
5. *Average Concentration (Avg) = Average of detected concentrations. If all results are non-detect, the maximum detection limit is shown.*

N W E S

0 800 1600
Feet

MWH

P_4 Production, LLC

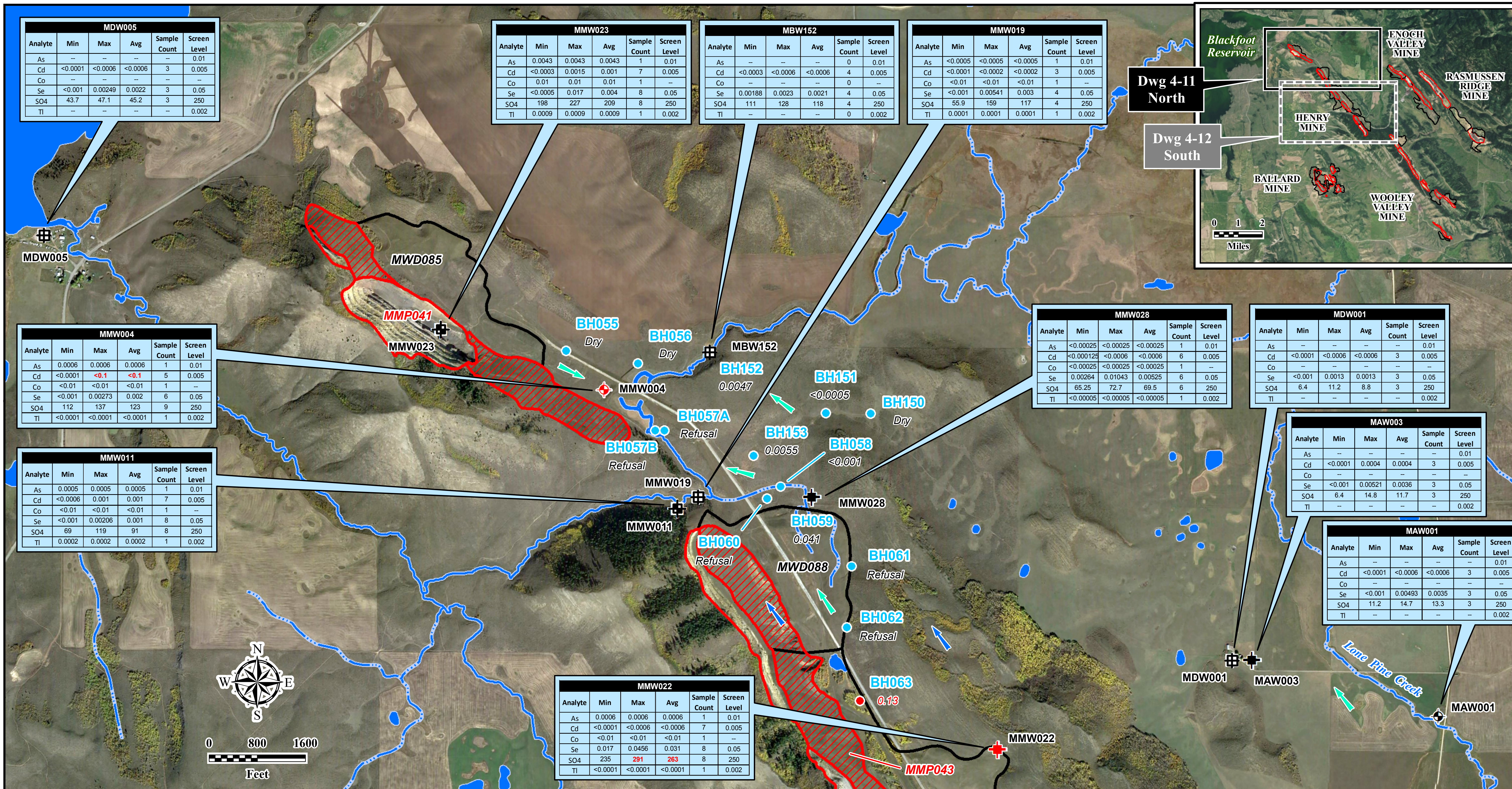
HENRY MINE REMEDIAL INVESTIGATION
HENRY - SOUTH
SURFACE WATER LOCATIONS
AND RESULTS
DRAWING 4-10

DRAWN BY D. Severson
17 July 2017
C:\Data\MWH\P4 Monsanto\HENRY_RI_Dec2015\FIGURES\Dwg 4-10_Henry Site South_SW Locs and Results_17Jul2017.mxd

DRAWN BY D. Severson

27 Feb 2017

C:\Data\MWH\P4 Monsanto\HENRY_RI_Dec2015\FIGURES\Dwg 4-11_Henry Site_GW Locs and Results_NORTH_27Feb2017.mxd



MDW005					
Analyte	Min	Max	Avg	Sample Count	Screen Level
As	--	--	--	--	0.01
Cd	<0.0001	<0.0006	<0.0006	3	0.005
Co	--	--	--	--	--
Se	<0.001	0.00249	0.0022	3	0.05
SO4	43.7	47.1	45.2	3	250
Tl	--	--	--	--	0.002

MMW023					
Analyte	Min	Max	Avg	Sample Count	Screen Level
As	0.0043	0.0043	0.0043	1	0.01
Cd	<0.0003	0.0015	0.001	7	0.005
Co	0.01	0.01	0.01	1	--
Se	<0.0005	0.017	0.004	8	0.05
SO4	198	227	209	8	250
Tl	0.0009	0.0009	0.0009	1	0.002

MBW152					
Analyte	Min	Max	Avg	Sample Count	Screen Level
As	--	--	--	0	0.01
Cd	<0.0003	<0.0006	<0.0006	4	0.005
Co	--	--	--	0	--
Se	0.00188	0.0023	0.0021	4	0.05
SO4	111	128	118	4	250
Tl	--	--	--	0	0.002

MMW019					
Analyte	Min	Max	Avg	Sample Count	Screen Level
As	<0.0005	<0.0005	<0.0005	1	0.01
Cd	<0.0001	<0.0002	<0.0002	3	0.005
Co	<0.01	<0.01	<0.01	1	--
Se	<0.001	0.00541	0.003	4	0.05
SO4	55.9	159	117	4	250
Tl	0.0001	0.0001	0.0001	1	0.002

MMW004					
Analyte	Min	Max	Avg	Sample Count	Screen Level
As	0.0006	0.0006	0.0006	1	0.01
Cd	<0.0001	<0.1	<0.1	5	0.005
Co	<0.01	<0.01	<0.01	1	--
Se	<0.001	0.00273	0.002	6	0.05
SO4	112	137	123	9	250
Tl	<0.0001	<0.0001	<0.0001	1	0.002

MMW011					
Analyte	Min	Max	Avg	Sample Count	Screen Level
As	0.0005	0.0005	0.0005	1	0.01
Cd	<0.0006	0.001	0.001	7	0.005
Co	<0.01	<0.01	<0.01	1	--
Se	<0.001	0.00206	0.001	8	0.05
SO4	69	119	91	8	250
Tl	0.0002	0.0002	0.0002	1	0.002

MMW028					
Analyte	Min	Max	Avg	Sample Count	Screen Level
As	<0.00025	<0.00025	<0.00025	1	0.01
Cd	<0.000125	<0.0006	<0.0006	6	0.005
Co	<0.00025	<0.00025	<0.00025	1	--
Se	0.00264	0.01043	0.00525	6	0.05
SO4	65.25	72.7	69.5	6	250
Tl	<0.00005	<0.00005	<0.00005	1	0.002

MDW001					
Analyte	Min	Max	Avg	Sample Count	Screen Level
As	--	--	--	--	0.01
Cd	<0.0001	<0.0006	<0.0006	3	0.005
Co	--	--	--	--	--
Se	<0.001	0.0013	0.0013	3	0.05
SO4	6.4	11.2	8.8	3	250
Tl	--	--	--	--	0.002

MAW003					
Analyte	Min	Max	Avg	Sample Count	Screen Level
As	--	--	--	--	0.01
Cd	<0.0001	0.0004	0.0004	3	0.005
Co	--	--	--	--	--
Se	<0.001	0.00521	0.0036	3	0.05
SO4	6.4	14.8	11.7	3	250
Tl	--	--	--	--	0.002

MAW001					
Analyte	Min	Max	Avg	Sample Count	Screen Level
As	--	--	--	--	0.01
Cd	<0.0001	<0.0006	<0.0006	3	0.005
Co	--	--	--	--	--
Se	<0.001	0.00493	0.0035	3	0.05
SO4	11.2	14.7	13.3	3	250
Tl	--	--	--	--	0.002

MMW022					
Analyte	Min	Max	Avg	Sample Count	Screen Level
As	0.0006	0.0006	0.0006	1	0.01
Cd	<0.0001	<0.0006	<0.0006	7	0.005
Co	<0.01	<0.01	<0.01	1	--
Se	0.017	0.0456	0.031	8	0.05
SO4	235	291	263	8	250
Tl	<0.0001	<0.0001	<0.0001	1	0.002

Agricultural, domestic or production well (unknown screen or multiple aquifers screened)

Local aquifer monitoring well (generally alluvial system)

Intermediate aquifer monitoring well (generally Dinwoody Fm.)

Regional aquifer monitoring well (Wells Fm.)

Direct push borehole

0.031 Selenium dissolved concentration in milligrams per liter

Alluvial flow arrow

Bedrock flow arrow (i.e., apparent hydraulic potential)

Mine pit location (approx)

Backfilled

Waste rock dump location

MAW	Agricultural well
MBW	Direct push borehole monitoring well
MDW	Domestic well
MMP	Mine pit
MWD	Waste rock dump
MMW	Monitor well
BH	One-time direct push borehole well

ANALYTES

As	Arsenic
Cd	Cadmium
Co	Cobalt
Se	Selenium
SO_4	Sulfate
Tl	Thallium

NOTES

1. *Data collected between 2004 and 2014.*
2. *Total (unfiltered) concentrations reported except for selenium in direct push boreholes where dissolved (filtered) concentrations are reported.*
3. *All concentrations reported in milligrams per liter (mg/l).*
4. *Concentrations and symbols* IN RED *indicate screening level exceedance.*
5. *Average Concentration (Avg) = Average of detected concentrations If all results are non-detect, the maximum detection limit is shown.*

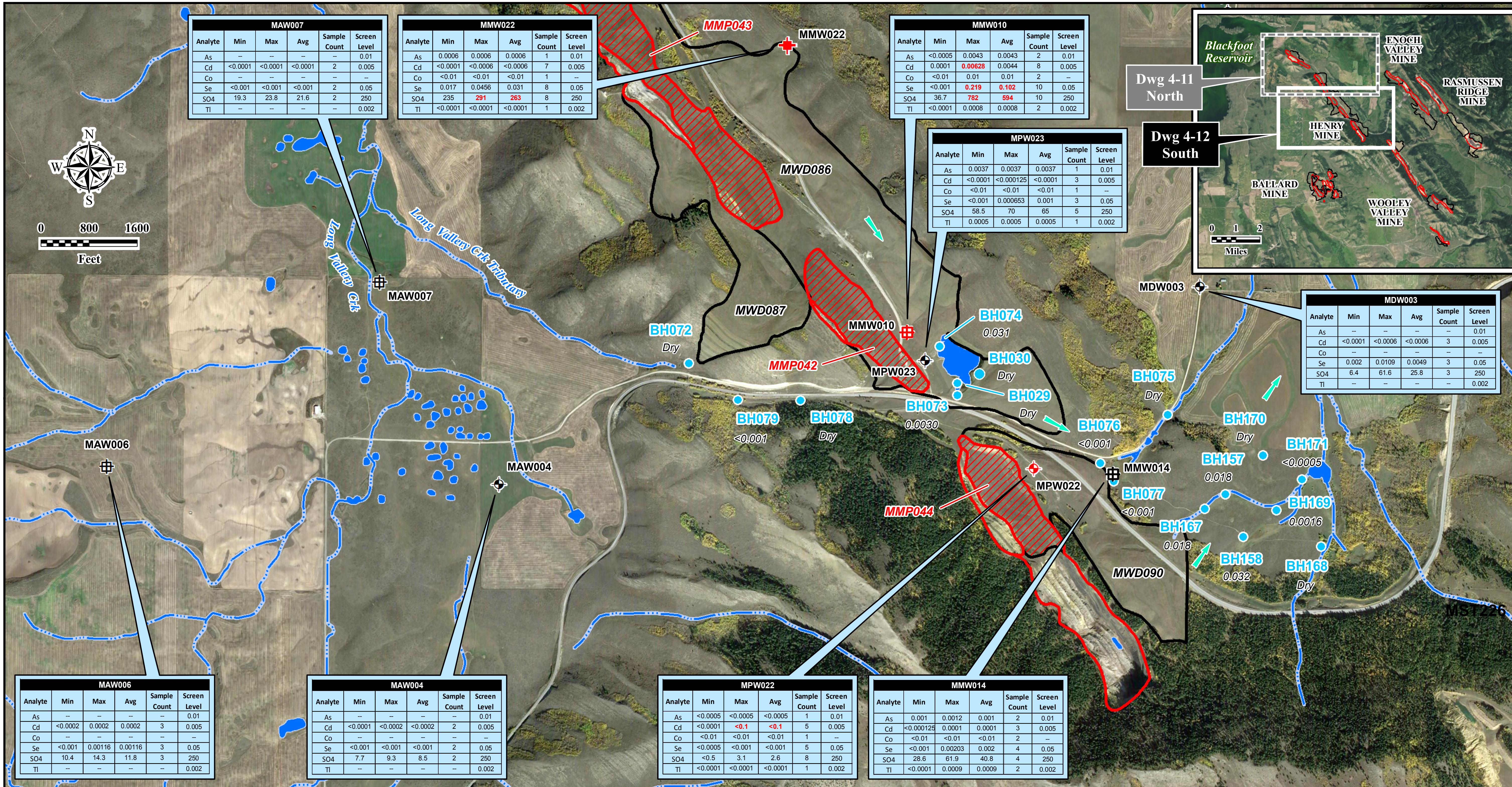
P_4 Production, LLC

HENRY MINE REMEDIAL INVESTIGATION
HENRY - NORTH
GROUNDWATER LOCATIONS AND RESULTS
DRAWING 4-11

DRAWN BY D. Severson

27 Feb 2017

C:\Data\MWH\P4 Monsanto\HENRY_RI_Dec2015\FIGURES\Dwg 4-12_Henry Site_GW Locs and Results_SOUTH_27Feb2017.mxd



MAW007

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	--	--	--	--	0.01
Cd	<0.0001	<0.0001	<0.0001	2	0.005
Co	--	--	--	--	--
Se	<0.001	<0.001	<0.001	2	0.05
SO4	19.3	23.8	21.6	2	250
Tl	--	--	--	--	0.002

MMW022

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	0.0006	0.0006	0.0006	1	0.01
Cd	<0.0001	<0.0006	<0.0006	7	0.005
Co	<0.01	<0.01	<0.01	1	--
Se	0.017	0.0456	0.031	8	0.05
SO4	235	**291**	**263**	8	250
Tl	<0.0001	<0.0001	<0.0001	1	0.002

MMW010

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	<0.0005	0.0043	0.0043	2	0.01
Cd	0.0001	**0.00628**	0.0044	8	0.005
Co	<0.01	0.01	0.01	2	--
Se	<0.001	**0.219**	**0.102**	10	0.05
SO4	36.7	**782**	**594**	10	250
Tl	<0.0001	0.0008	0.0008	2	0.002

MPW023

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	0.0037	0.0037	0.0037	1	0.01
Cd	<0.0001	<0.000125	<0.0001	3	0.005
Co	<0.01	<0.01	<0.01	1	--
Se	<0.001	0.000653	0.001	3	0.05
SO4	58.5	70	65	5	250
Tl	0.0005	0.0005	0.0005	1	0.002

MDW003

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	--	--	--	--	0.01
Cd	<0.0001	<0.0006	<0.0006	3	0.005
Co	--	--	--	--	--
Se	0.002	0.0109	0.0049	3	0.05
SO4	6.4	61.6	25.8	3	250
Tl	--	--	--	--	0.002

MAW006

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	--	--	--	--	0.01
Cd	<0.0002	0.0002	0.0002	3	0.005
Co	--	--	--	--	--
Se	<0.001	0.00116	0.00116	3	0.05
SO4	10.4	14.3	11.8	3	250
Tl	--	--	--	--	0.002

MAW004

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	--	--	--	--	0.01
Cd	<0.0001	<0.0002	<0.0002	2	0.005
Co	--	--	--	--	--
Se	<0.001	<0.001	<0.001	2	0.05
SO4	7.7	9.3	8.5	2	250
Tl	--	--	--	--	0.002

MPW022

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	<0.0005	<0.0005	<0.0005	1	0.01
Cd	<0.0001	**<0.1**	**<0.1**	5	0.005
Co	<0.01	<0.01	<0.01	1	--
Se	<0.0005	<0.001	<0.001	5	0.05
SO4	<0.5	3.1	2.6	8	250
Tl	<0.0001	<0.0001	<0.0001	1	0.002

MMW014

Analyte	Min	Max	Avg	Sample Count	Screen Level
As	0.001	0.0012	0.001	2	0.01
Cd	<0.000125	0.0001	0.0001	3	0.005
Co	<0.01	<0.01	<0.01	2	--
Se	<0.001	0.00203	0.002	4	0.05
SO4	28.6	61.9	40.8	4	250
Tl	<0.0001	0.0009	0.0009	2	0.002

Agricultural, domestic or production well (unknown screen or multiple aquifers screened)

Local aquifer monitoring well (generally alluvial system)

Intermediate aquifer monitoring well (generally Dinwoody Fm.)

Regional aquifer monitoring well (Wells Fm.)

Direct push borehole

0.031 Selenium dissolved concentration in milligrams per liter

Alluvial flow arrow

Bedrock flow arrow (i.e., apparent hydraulic potential)

Mine pit location (approx)

Backfilled

Waste rock dump location

MAW	Agricultural well
MBW	Direct push borehole monitoring well
MDW	Domestic well
MMP	Mine pit
MWD	Waste rock dump
MMW	Monitor well
BH	One-time direct push borehole well

ANALYTES

As	Arsenic
Cd	Cadmium
Co	Cobalt
Se	Selenium
SO_4	Sulfate
Tl	Thallium

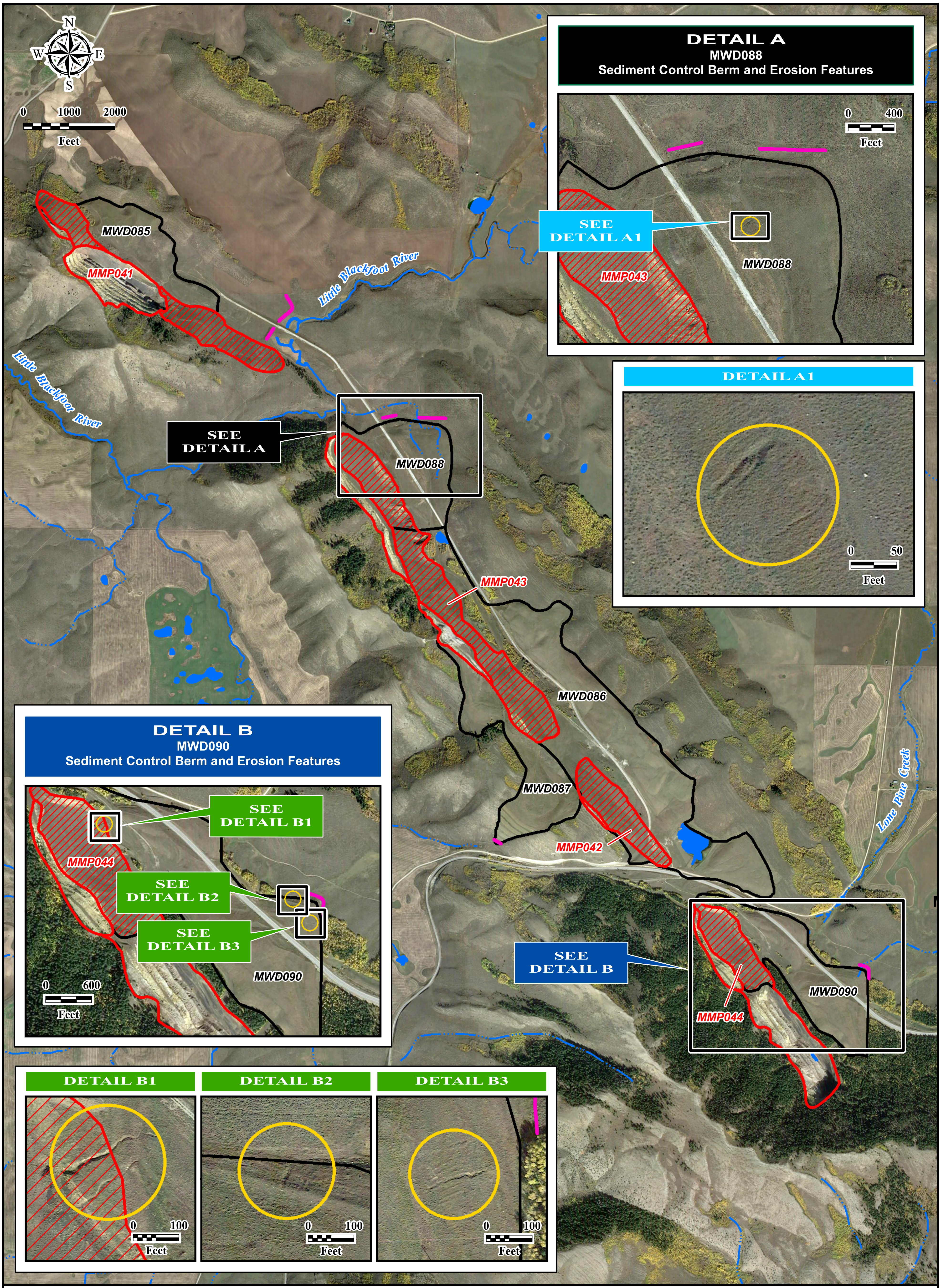
NOTES

1. *Data collected between 2004 and 2014.*
2. *Total (unfiltered) concentrations reported except for selenium in direct push boreholes where dissolved (filtered) concentrations are reported.*
3. *All concentrations reported in milligrams per liter (mg/l).*
4. *Concentrations and symbols* **IN RED** *indicate screening level exceedance.*
5. *Average Concentration (Avg) = Average of detected concentrations If all results are non-detect, the maximum detection limit is shown.*

P_4 Production, LLC

HENRY MINE REMEDIAL INVESTIGATION
HENRY - SOUTH
GROUNDWATER LOCATIONS AND RESULTS
DRAWING 4-12

SECTION 5.0 DRAWINGS



Mine pit location (approximate)

Backfilled

Waste rock dump location

Sediment control berm

Cover erosion area

MWH

P4 Production, LLC

HENRY MINE REMEDIAL INVESTIGATION

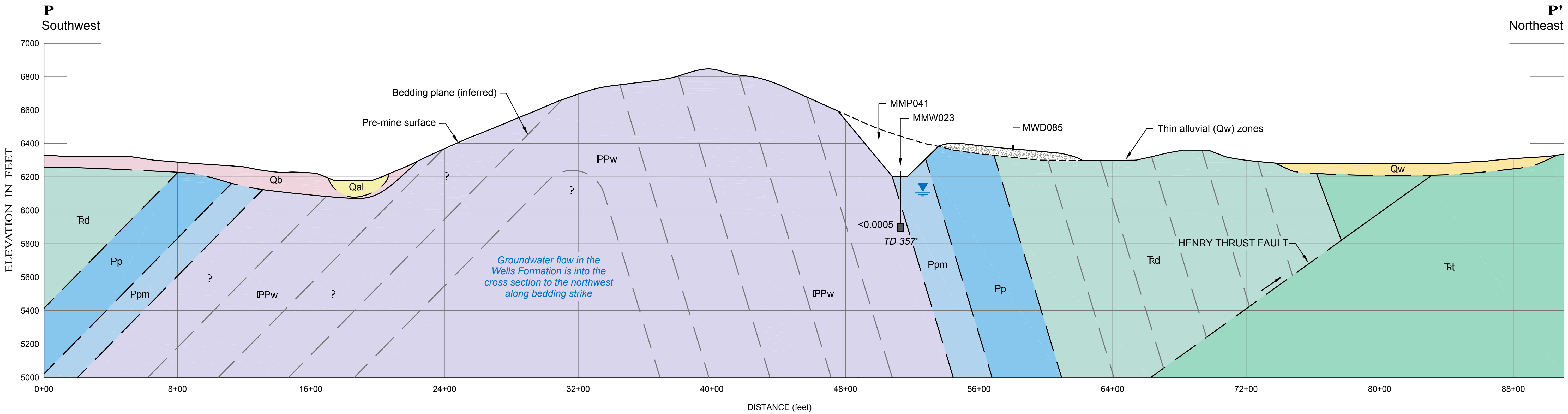
SEDIMENT BERMS AND EROSION

DRAWING 5-1

DRAWN BY D. Severson

21 Apr 2017

C:\MWH\P4 Monsanto\HENRY_RI_Dec2015\FIGURES\Dwg 2-6_Henry Mine_Cross Section_P-P_20Apr2017.ai



SECTION P-P'

Looking Northwest

0 300 600

Horizontal and Vertical Scale in Feet

NO VERTICAL EXAGGERATION

Waste rock

Pre-mine surface (where different from current surface)

Geologic contact (dashed where approximate or inferred)

Fault, showing direction of displacement (dashed where inferred)

Schematic groundwater flow vector

6236' Measured groundwater elevation (feet above mean sea level)

0.017 Measured total selenium concentration in mg/L (spring 2014 sample, unless otherwise noted)

Monitoring well location showing approximate screen location

GEOLOGY KEY

Symbol	Unit
Qb	Basalt
Qal	Alluvium
Qw	Colluvium and older alluvium
TRt	Thaynes formation
TRd	Dinwoody Formation - Woodside Shale
Pp	Phosphoria Formation
Ppm	Meade Peak Member
PPw	Wells Formation

NOTES

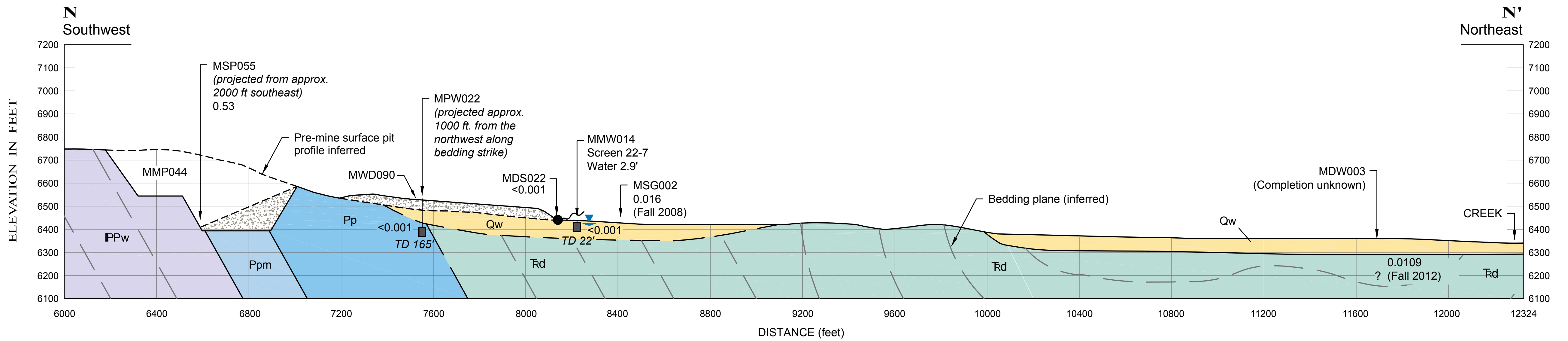
1. *Adapted from Mansfield (1927).*
2. *Mine pit and waste rock are shown schematically.*
3. *Section line indexed on Drawing 2-2.*
4. *Data for all sampling events are tabulated in Appendix B.*

P_4 Production, LLC

HENRY MINE REMEDIAL INVESTIGATION

SCHEMATIC GEOLOGIC CROSS SECTION P-P'

Drawing 5-2



SECTION N-N'
Looking Northwest

0 250 500

Horizontal and Vertical Scale in Feet
NO VERTICAL EXAGGERATION

Waste rock	Schematic groundwater flow vector
Pre-mine surface (where different from current surface)	6236' Measured groundwater elevation (feet above mean sea level)
Geologic contact (dashed where approximate or inferred)	0.017 Measured total selenium concentration in mg/L (spring 2008 sample, unless otherwise noted)
Fault, showing direction of displacement (dashed where inferred)	Monitoring well location showing approximate screen location
Seep/spring	

GEOLOGY KEY

Qw	Colluvium and older alluvium	Pp / Ppm	Phosphoria Formation Meade Peak Member
Ꞧd	Dinwoody Formation Woodside Shale	IPPw	Wells Formation

NOTES

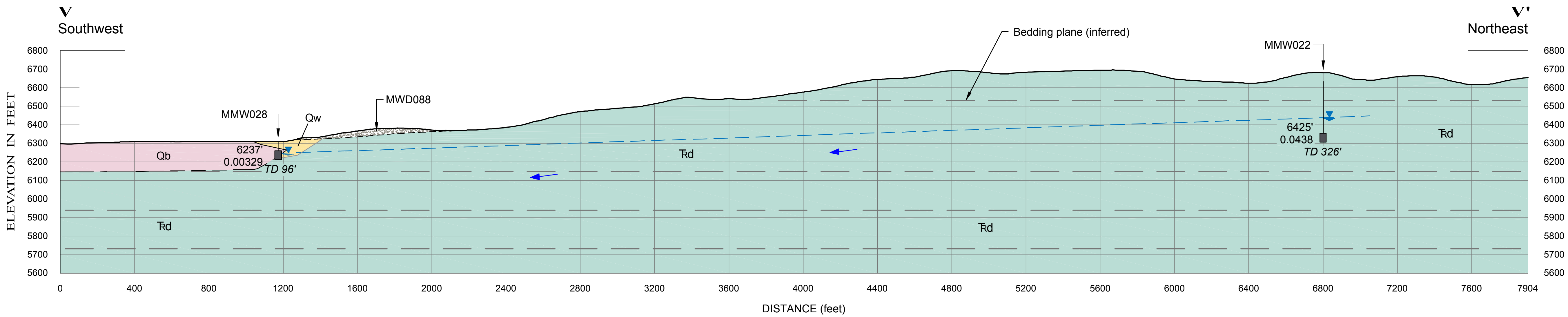
1. *Adapted from Mansfield (1927).*
2. *Mine pit and waste rock are shown schematically.*
3. *Section line indexed on Drawing 2-2.*
4. *Data for all sampling events are tabulated in Appendix B.*

P$_4$ Production, LLC

HENRY MINE REMEDIAL INVESTIGATION

SCHEMATIC GEOLOGIC CROSS SECTION N-N'
Drawing 5-3

DRAWN BY D. Severson
21 Apr 2017
C:\MWH\P4 Monsanto\HENRY_RI_Dec2015\FIGURES\Dwg 2-5_Henry Mine_Cross Section_N-N_20Apr2017.ai



SECTION V-V'
Looking Northwest

0 300 600

Horizontal and Vertical Scale in Feet
NO VERTICAL EXAGGERATION

Legend	
	Waste rock
	Pre-mine surface (where different from current surface)
	Geologic contact (dashed where approximate or inferred)
	Schematic groundwater flow vector
6236'	Measured groundwater elevation (feet above mean sea level)
	Potentiometric surface
0.017	Measured total selenium concentration in mg/L (spring 2014 sample, unless otherwise noted)
	Monitoring well location showing approximate screen location

GEOLOGY KEY

Qb	Basalt
Qw	Colluvium and older alluvium
TRd	Dinwoody Formation - Woodside Shale

NOTES

1. *Adapted from Mansfield (1927).*
2. *Mine pit and waste rock are shown schematically.*
3. *Section line indexed on Drawing 2-2.*
4. *Data for all sampling events are tabulated in Appendix B.*

P_4 Production, LLC

HENRY MINE REMEDIAL INVESTIGATION

SCHEMATIC GEOLOGIC CROSS SECTION V-V'

Drawing 5-4

DRAWN BY D. Severson

21 Apr 2017

C:\MWH\P4 Monsanto\HENRY_RI_Dec2015\FIGURES\Dwg 2-7_Henry Mine_Cross Section_V-V_20Apr2017.ai

APPENDICES

Appendix A - Baseline Risk Assessment Report for the Henry Site
Appendix B - Remedial Investigation Analytical Data
Appendix C - Photographic Log of Surface Water Sampling Locations
Appendix D - Comments and Comment Responses Documents

APPENDIX A

BASELINE RISK ASSESSMENT REPORT FOR THE HENRY SITE

APPENDIX A

BASELINE RISK ASSESSMENT REPORT
FOR THE HENRY MINE

FINAL

OCTOBER 2017

Prepared by

MWH

Prepared for:

P4 Production, LLC

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ATTACHMENTS

ACRONYMS AND ABBREVIATIONS

95% CI	95 percent confidence interval
95% UCL	95 percent upper confidence level
97.5% UCL	97.5 percent upper confidence level
99% UCL	99 percent upper confidence level
μg	micrograms
Ag	silver
Al	aluminum
AOC	Administrative Settlement Agreement and Order on Consent
A/T	Agencies and Tribes
ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	ambient water quality criteria
BAF	bioaccumulation factor
bgs	below ground surface
BLM	Bureau of Land Management (United States)
BMP	best management practice
BRA	baseline risk assessment
BTAG	Biological Technical Assistance Group
bw	body weight
Ca	calcium
CalEPA	California Environmental Protection Agency
CCC	continuous chronic criteria
Cd	cadmium
CEC	cation exchange capacity
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contact Laboratory Program
cm	centimeters
cm^2	square centimeters
cm^3	cubic centimeters
CMC	criterion maximum concentration
CO	consent order
COPC	constituent of potential concern
COPEC	constituent of potential ecological concern
Cprey	concentration in prey item
Cr III	chromium III
CSF	carcinogenic slope factor
CSM	conceptual site model
CTE	central tendency exposure
d	day
DOC	dissolved organic carbon
EC	exposure concentration
EcoSSL	Ecological Soil Screening Level
EPC	exposure point concentration
ERA	ecological risk assessment
FIR	food ingestion rate
FMR	free-living metabolic rate
Fprey	fraction of pretty items in diet
FS	feasibility study

g	gram
g/kg-d	grams per kilogram per day
H^+	hydrogen ions
HEAST	Health Effects Assessment Summary Tables
Henry Site	Henry Mine and vicinity
HHERA	human health and ecological risk assessment
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
ILCR	incremental lifetime cancer risk
IDAPA	Idaho Administrative Procedures Act
IDEQ	Idaho Department of Environmental Quality
IRIS	Integrated Risk and Information System
kg	kilogram
L	liter
LC	lethal concentration
LCOPC	livestock constituent of potential concern
LCV	lowest chronic value
LMS	linearized multistage
LOAEL	lowest observed adverse effects level
LRA	livestock risk assessment
m^3	cubic meters
MCL	maximum contaminant level
MDL	method detection limit
MF	modifying factor
Mg	magnesium
mg	milligram
MLF	mass loading factor
Mn	manganese
MWH	MWH Americas, Inc.
NRWQC	National Recommended Water Quality Criteria
MSHA	Mining Safety and Health Administration
Ni	nickel
NOAEL	no observed adverse effects level
ORNL	Oak Ridge National Laboratories
P4	P4 Production, LLC
Pb	lead
PBT	persistent, bioaccumulative and toxic
pCi/g	picoCuries per gram
pCi/L	picoCuries per liter
PEF	particulate emission factor
PPRTV	Provisional Peer Reviewed Toxicity Values
PRG	preliminary remediation goal
QC	quality control
RAGS	Risk Assessment Guidance for Superfund
RAIS	Risk Assessment Information System
RBA	Relative bioavailability factor
RBP	Rapid Bioassessment Protocol
RBS	relative bed stability

REM	Risk Evaluation Manual
RfC	reference concentration
RfD	reference dose
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
RME	reasonable maximum exposure
ROPC	radionuclide of potential concern
RSL	Regional Screening Levels
SARA	Superfund Amendments and Reauthorization Act
SCV	secondary chronic value
SE	southeast
SEGW	surface expressions of groundwater
SUF	site utilization factor
Tribes	Shoshone-Bannock Tribes
TRV	toxicity reference value
UF	uncertainty factor
URF	unit risk factor
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USDOI	United States Department of the Interior
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
WI	water ingestion rate
wt	weight
Zn	zinc

1.0 INTRODUCTION

This baseline risk assessment report (BRA Report) for the Henry Mine and vicinity (Henry Site) was prepared by MWH Americas, Inc. (MWH) on behalf of P4 Production, LLC (P4), in accordance with the requirements set forth in the Administrative Settlement Agreement and Order on Consent/Consent Order for Remedial Investigation/Feasibility Study (CO/AOC RI/FS) (USEPA, 2009a). The 2009 CO/AOC is a voluntary agreement between P4 and the United States Environmental Protection Agency (USEPA), the Idaho Department of Environmental Quality (IDEQ), the United States Department of Agriculture (USDA), United States Forest Service (USFS), the U.S. Department of the Interior (USDOI), Bureau of Land Management (BLM), and the Shoshone-Bannock Tribes (Tribes). This group of stakeholders is collectively referred to as the "Agencies and Tribes" or A/T. This BRA Report is part of the Henry Mine RI Report that supports the comprehensive site-specific RI/FS that is being conducted at P4's three historic phosphate mines, namely the Ballard, Henry, and Enoch Valley Mines (collectively known as the "Sites"), located in southeast (SE) Idaho. The Henry Site includes both the mine features, such as mine pits and waste rock dumps, and impacted areas away from mine features, including off-mine surface water and groundwater. The BRA for the Henry Site was conducted according to the methodologies and exposure scenarios presented in the Human Health and Ecological Risk Assessment (HHERA) Work Plan (Appendix C of the *RI/FS Work Plan*; MWH, 2011), as applied in the BRA for P4's Ballard Mine (MWH, 2014).

1.1 Objectives and Scope

The purpose of this BRA Report is to present (1) the methods and procedures used in the evaluation of potential human health, ecological, and livestock risks associated with media of concern at the Henry Site, (2) the receptor-specific human health, ecological, and livestock risk and hazard estimates, and (3) the risk assessment conclusions for the Henry Site. While the BRA for the Henry Site was patterned after similar RIs performed in SE Idaho, the approach used in this assessment incorporates changes in the current regulatory setting, state of risk assessment science, and Site-specific conditions at the Henry Site.

1.2 Scope of the Risk Assessment

The scope of this BRA Report includes the methods and assumptions used in, and results of, the BRA for the Henry Site. The methods and results described herein include the following:

- Establishment of requirements for the selection of environmental data to be evaluated in the BRA.
- Identification of criteria for the selection of constituents of potential concern (COPCs), radionuclides of potential concern (ROPCs), constituents of potential ecological concern (COPECs), and livestock constituents of potential concern (LCOPC) to be evaluated in the BRA.
- Determination of habitat types and potential beneficial/multiple uses at the Henry Site.
- Creation of conceptual site models (CSMs) which identify complete exposure pathways for human, ecological, and livestock receptors.
- Presentation of exposure equations for quantifying exposure doses.
- Establishment of information sources and procedures for the human health, ecological, and livestock toxicity assessment.

- Development of procedures for the characterization of human health, ecological, and livestock risks.
- Quantitative and qualitative evaluations of risks to human, ecological, and livestock receptors.
- Identification and discussion of uncertainties in the risk assessment process.

The BRA is part of the RI/FS process for the Henry Site. The goal of characterizing risks for the Henry Site is to determine which areas, if any, will require further evaluation or implementation of remedial measures. A tiered approach was used during the evaluation of risks to human, ecological, and livestock receptors for the Henry Site. The screening-level Tier I assessment used maximum concentrations of Site contaminants and reasonable maximum exposure (RME) assumptions, and the baseline Tier II assessment was based on the lower of the upper-bound average or the maximum detected concentrations and both RME and central tendency exposure (CTE) assumptions, as described in Sections 3.0, 4.0, and 5.0 of this BRA Report.

1.3 Process and Organization

This BRA Report is organized into the following sections:

- Section 1 – Introduction
- Section 2 – Data Evaluation and Summary
- Section 3 – Human Health Risk Assessment
- Section 4 – Ecological Risk Assessment
- Section 5 – Livestock Risk Assessment
- Section 6 - Uncertainty Analysis
- Section 7 – Conclusions
- Section 8 – References

2.0 DATA EVALUATION AND SUMMARY

This section describes procedures for evaluating and selecting the data that was evaluated in this BRA. The environmental media and data that were quantitatively evaluated include soil (upland and riparian), surface water (upstream, downstream, and pond), groundwater, sediment, and vegetation (upland and riparian plants) collected between 2004 and 2014. The data evaluation process is presented in Section 5.5 and Appendix B of the *RI/FS Work Plan*.

2.1 Site Data Selection

For an analytical result to be usable for assessing risk, the sample collection, preparation, and analytical methods should appropriately identify the chemical form or species present, and the specified sample detection limit should be at or below a concentration that is associated with toxicologically relevant levels (e.g., published risk-based screening levels or action levels). The significance of analytical detection limits greater than such criteria was evaluated on a case-by-case basis and was described in the uncertainty section of this BRA Report.

According to the USEPA (1989), only field investigation analytical data that meet specific requirements are appropriate for use in a quantitative human health risk assessment (HHRA). Only data collected and analyzed at a quality control (QC) level equivalent to USEPA Level III or higher (USEPA, 1988) meets appropriate usability criteria for evaluation in a quantitative HHRA. USEPA Level III data provide the following:

- Low detection limits.
- A wide range of calibrated analyses.
- Matrix recovery information.
- Laboratory process control information.
- Known precision and accuracy.

The abiotic media and vegetation sampling data that were quantitatively evaluated in the BRA are consistent with USEPA level III and are suitable for risk assessment purposes.

Data that meet USEPA Contract Laboratory Program (CLP) Level III or Level IV (or functionally equivalent) data validation criteria are not required for quantitative ecological risk assessments.

USEPA's Guidance for Data Usability in Risk Assessment (Part A) – Final (USEPA, 1992a), further states:

- Data are almost always useable in the risk assessment process, as long as the uncertainty in the data and its impact on the risk assessment are thoroughly explained.
- The analytical data objective for baseline risk assessments is that uncertainty is known and acceptable, not that uncertainty be reduced to a particular level.
- Sampling variability typically contributes much more to 'total error' than analytical variability.
- Field methods can produce legally defensible data if appropriate method QC is available and if documentation is adequate.
- Qualified data can usually be used for quantitative risk assessment.

- Data qualified as "U" or "J" should be used for risk assessment purposes.
- The primary planning objective is that uncertainty levels are acceptable, known and quantifiable, not that uncertainty is eliminated.

All validated and A/T-approved chemical data from the previous sampling investigations were evaluated for chemical, exposure, spatial and temporal representativeness prior to inclusion in the BRA, as follows:

- Chemical representativeness — Identified whether analyses were conducted for constituents expected to be present, on the basis of an understanding of historical processes or practices and potential releases at the site.
- Exposure representativeness—Identified whether environmental media were evaluated where receptor exposure is most feasible (including potential hot spots).
- Spatial representativeness — Identified whether samples were collected with a sufficient density and areal coverage that the detected constituent concentrations represent a geographically-integrated exposure for the receptors of concern.
- Temporal representativeness — Identified whether samples were collected within a time frame such that detected constituent concentrations indicate current site conditions.

Data that are determined to be representative, based on the above parameters, and deemed appropriate for inclusion in the BRA were further evaluated based on the following criteria:

- If a single, unqualified value was provided for a given sample/location/data, the value was used "as-is."
- If a chemical was detected at least once in soil, the non-detects were included in the database as well.
- Data qualified with "R" was removed from the database, while other qualified data was entered.
- Laboratory duplicates and quality control data were not included in the HHRA data set.
- For field duplicates and their respective primary samples, the following selection process was used:

    - If both results were reported as detected concentrations, the average concentration was calculated and used in all further data analysis steps.
    - If one result was reported as detected and the other result was reported as not detected, the detected result was used in all further data analysis steps.
    - If both results were reported as not detected, the higher detection limit of the two sample results was assigned to the sample and used in further data analysis steps.

- For field triplicates and their respective primary samples, the following selection process were used:

    - If all three results were reported as detected concentrations, the average concentration was calculated and used in all further data analysis steps.
    - If any two of the three results were reported as detected and the other result was reported as not detected, the average concentration of the detected results was calculated and used in all further data analysis steps.

- If any one of the three results was reported as detected and the other two results were both reported as not detected, the detected result was selected and use in all further data analysis steps.
- If all three results were reported as not detected, the higher detection limit of the sample results was assigned to the sample and used in further data analysis steps.
- Data qualification flags were maintained when averaging; any "J" flags associated with detected values were carried through to the final result.

The Henry Site data used in this BRA are summarized in **Table A2-1** through **Table A2-7**.

2.2 Site-Specific Background Data

Site-specific background data evaluated in this BRA were presented in the *Final Background Levels Development Technical Memorandum* (*Final Background TM*) (MWH, 2013) and the *On-Site and Background Areas Radiological and Soil Investigation Summary Report* (MWH, 2015). Background data at the Henry Site are available for upland and riparian soil, sediment, upland and riparian vegetation, surface water, and groundwater. Background data that met data usability criteria specified in Section 2.1, and for which the A/Ts concur, was employed for purposes of calculating background carcinogenic risks and noncarcinogenic hazards for comparison to Site risks and hazards and for the calculation of incremental carcinogenic risks and noncarcinogenic hazards. Incremental carcinogenic risks and noncarcinogenic hazards represent the carcinogenic risks and noncarcinogenic hazards above those attributable to background concentrations.

3.0 HUMAN HEALTH RISK ASSESSMENT

The HHRA portion of this BRA Report focuses on potential risks associated with human exposures to Site-derived contaminants under current and potential future land uses. Results of this HHRA will be used to evaluate whether current concentrations of COPCs and ROPCs in Site media are protective of human health and may remain in place, or if remedial measures are required. Risks to public health were evaluated in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) process, as amended by Superfund Amendments and Reauthorization Act (SARA). Potential threats to ecological habitats and receptors were evaluated as described in Section 4.0, and potential threats to livestock were evaluated as described in Section 5.0.

The HHRA for the Henry Site was performed in accordance with, or in consideration of, the following USEPA and State of Idaho guidance documents and/or reference materials:

- Risk Assessment Guidance for Superfund (RAGS). Volume I: Human Health Evaluation Manual, Part A (USEPA, 1989)
- RAGS. Volume I: Human Health Evaluation Manual, Part F - Supplemental Guidance for Inhalation Risk Assessment (USEPA, 2009b)
- Guidelines for Carcinogen Risk Assessment (USEPA, 2005a)
- Child-Specific Exposure Factors Handbook - Final Report (USEPA, 2008a)
- Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors (USEPA, 1991a)
- Role of the Baseline Risk Assessment in Superfund Remedy Selection Decision (USEPA, 1991b)
- Final Exposure Assessment Guidelines (USEPA, 1992b)
- Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997a)
- Exposure Factors Handbook (USEPA, 1997b; 2011)
- RAGS Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) (USEPA, 2004)
- Risk Evaluation Manual (REM) (IDEQ, 2004a)
- Surface Water Quality Standards. Idaho Administrative Procedures Act (IDAPA) 58.01.02 (IAC, 2009a)
- Groundwater Quality Rule. IDAPA 58.01.11 (IAC, 2009b)

Site cleanup rules provided in the aforementioned documents establish administrative processes and standards to determine the necessity for, and/or degree of, cleanup required to protect human health, safety, and welfare, and the environment at a site where one or more hazardous substances are located.

Medium-specific constituents proposed for evaluation for the P4 Sites have already been developed and approved by the A/Ts; these are the analytes measured within each medium. Selection of COPCs from these medium-specific constituents involved a comparison of maximum detected concentrations to published screening criteria, as described in Section 3.1, below. Constituents having maximum detected concentrations that exceed screening levels were identified as COPCs and evaluated further in successive Tier I and Tier II HHRAs.

The Tier I assessment used RME assumptions and maximum detected concentrations as the exposure point concentrations (EPCs). Constituents in each exposure medium posing an unacceptable risk or hazard in the Tier I risk assessment were carried forward into a Tier II HHRA. The Tier II HHRA calculated risks separately using CTE and RME assumptions and upper bound average concentrations for EPCs, or maximum detected concentrations for datasets where there were an insufficient number of detected sample results to perform statistics. Tier I and Tier II risks were also calculated for background concentrations, and incremental risks were derived from the Tier II RME-based calculations.

3.1 COPC Selection

The goal of the HHRA is to estimate potential risks to human receptors from Site-related constituents under reasonable exposure scenarios (USEPA, 1989). To ensure that the primary focus of the HHRA is on the Site-related constituents that are of most concern, medium-specific COPCs and ROPCs were screened against protective human health screening criteria for a residential scenario, in order to evaluate whether constituent concentrations meet unrestricted land use criteria.

Human health screening criteria include numeric criteria and standards published in Federal regulations, State of Idaho regulations, and other regional reports. Federal sources for numeric screening criteria include USEPA Regional Screening Levels (RSLs; USEPA, 2015a), National Recommended Water Quality Criteria (NRWQC) (USEPA, 2016a), and National Maximum Contaminant Levels (MCLs) (USEPA, 2016b). Idaho standards include Water Quality Standards published in IDAPA 58.01.02 (IAC, 2009a), Groundwater Quality Rule published in IDAPA 58.01.02 (IAC, 2009b) the Area-Wide Risk Management Plan (IDEQ, 2004b), and Idaho Health Comparison Levels for Drinking Water (ATSDR, 2006). Radionuclides in upland soil were screened against screening levels calculated in the USEPA's Preliminary Remediation Goal (PRG) calculator (USEPA, 2015d). The most recent version of the USEPA RSLs at the time of the risk assessment was used during COPC screening for soil, surface water and groundwater in the HHRA. Subsequent to the screening process the USEPA published updated RSLs (May, 2016), however, none of the screening value updates were for constituents evaluated in samples from the Henry Site.

Constituents and radionuclides were included as COPCs and ROPCs if Henry Site-specific maximum detected concentrations exceed published medium-specific screening levels.

3.1.1 COPC/ROPC Selection Criteria

Medium-specific human health COPC screening for the Henry Site is presented in **Table A3-1** through **Table A3-5**. Radionuclide data, including radon flux from soil to air, are available for upland soil only; ROPC screening is presented in **Table A3-1**.

Surface Soil:

Human health COPC screening for upland and riparian surface soil was based on comparison of maximum concentrations of constituents detected in soil to USEPA RSLs (USEPA, 2015a) for carcinogenic constituents (equivalent to a one-in-one million risk) and one-tenth of the USEPA RSLs for non-carcinogens. ROPC screening for upland soil was based on comparison of maximum concentrations of radium-226 and radon-222 to residential soil and indoor air PRGs for radionuclides plus decay chain daughter products, respectively, equivalent to a one-in-one million risk.

Constituents in upland and riparian soil, and radionuclides in upland soil, that exceeded the COPC soil screening benchmarks were identified as human health COPCs and ROPCs (**Table A3-1** and **Table A3-2**). The screening approach that was used to identify COPCs for soil was also used to identify COPCs for sediment. Human health sediment screening is presented in **Table A3-4**. Radionuclide data are not available for riparian soil and sediment; radium-226 was identified as an ROPC in sediment because total uranium was identified as a COPC in that medium.

Surface Water:

Human health COPC screening for surface water was based on comparison of maximum concentrations of constituents detected in surface water to the following hierarchy of criteria:

1. State of Idaho Surface Water Quality for Domestic Water Supply Use (IDAPA 58.01.02) (IAC, 2009a) which is applied to all potential domestic use surface waters in the State of Idaho. The lower of the human health criteria for drinking water and consumption of organisms within the water is applied.
2. NRWQC (USEPA, 2016a) presented for human health include the consumption of organisms within the surface water body and for a combination of consumed organisms and ingestion of water.
3. USEPA RSLs for tap water (USEPA, 2015a).
4. Idaho Health Comparison Levels for Drinking Water (ATSDR, 2006), presented in Public Health Assessment for Bannock, Bear Lake, Bingham, and Caribou Counties in Idaho.
5. USEPA primary and secondary Maximum Contaminant Levels (MCLs) (USEPA, 2016b), criteria represent the national primary drinking water standards.

Constituents exceeding the selected water quality criteria were identified as human health COPCs for surface water (**Table A3-3**). Radionuclide data are not available for surface water; radium-226 was not identified as an ROPC in this medium because total uranium was not identified as a COPC.

Groundwater:

Human health COPC screening for groundwater were based on comparison of maximum concentrations of constituents detected in groundwater to:

1. USEPA RSLs for tap water (USEPA, 2015a).
2. Remedial action and monitoring levels; Area-Wide Risk Management Plan (IDEQ, 2004b).
3. State of Idaho Ground Water Quality Rule (IDAPA 58.01.11) (IAC, 2009b)
4. USEPA primary and secondary MCLs and National Primary Drinking Water Regulations (USEPA, 2016b)
5. Idaho Health Comparison Levels for Drinking Water (ATSDR, 2006), presented in Public Health Assessment for Bannock, Bear Lake, Bingham, and Caribou Counties in Idaho.

Constituents exceeding the selected COPC screening benchmarks were identified as human health COPCs for groundwater at the Henry Site, as presented in **Table A3-5**. Radionuclide data are not available for groundwater; radium-226 was not identified as an ROPC in this medium because total uranium was not identified as a COPC.

Constituents that were retained for further evaluation in the quantitative HHRA were included in the calculation of Henry Site risk estimates, background risk estimates, and incremental risk estimates, as described in Section 3.3.2.2. A summary of COPCs for the Henry Site are presented in **Table A3-6**.

Per comments received on the *RI/FS Work Plan*, it was agreed that following the risk screening process, prior to eliminating a COPC from further evaluation, a consideration will be made as to whether the COPC is potentially bioaccumulative. COPCs identified as potentially bioaccumulative by USEPA (2006b) were considered as a starting point for this determination. However, the risk screening results along with Site-specific biotic and abiotic data were also used to support decisions on refining the list of COPCs carried forward into the Tier I and Tier II HHRA.

3.2 Tier I HHRA

The Tier I HHRA, also referred to as a screening-level risk assessment, was performed on those constituents carried forward as COPCs from the COPC screening step. The Tier I HHRA quantitatively evaluated carcinogenic risks and noncarcinogenic hazard estimates for COPCs consistent with the documents mentioned earlier in this section of the BRA Report. The Tier I HHRA evaluation for the Henry Site was performed for current/future Native American, hypothetical future resident and current/future seasonal rancher scenarios using RME exposure assumptions (**Table A3-7**) and maximum detected concentrations of COPCs. Since these three exposure scenarios cover all relevant abiotic and biotic exposure pathways, carcinogenic risk and noncarcinogenic hazard estimates for these receptors are assumed to be protective of the remaining human receptors evaluated in this HHRA (refer to **Figure A3-1**). The Tier I exposure assessment and general HHRA process follows the Tier II baseline risk assessment steps detailed in Section 3.3 below. In addition to Henry Site risks and hazards, the Tier I HHRA also included risk and hazard estimates based on maximum detected concentrations from background locations and RME exposure assumptions.

When Tier I cumulative carcinogenic risk and noncarcinogenic hazard estimates were below IDEQ's point of departure and USEPA's risk management range for carcinogenic risk equal to 1×10^{-5} and 1×10^{-6} to 1×10^{-4}, respectively and IDEQ's and USEPA's noncarcinogenic hazard criterion equal to 1, the medium was not evaluated further in the HHRA.

3.3 Tier II HHRA

Constituents and media that exceeded IDEQ's point of departure and USEPA's risk management range for carcinogenic risk, and IDEQ's and USEPA's noncarcinogenic hazard criterion were further evaluated in the Tier II HHRA, also referred to as the baseline HHRA. All six human receptors identified in **Figure A3-1** for the Henry Site were quantitatively evaluated in the Tier II HHRA, as appropriate. The Tier II HHRA evaluated upper-bound average concentrations using both RME and CTE assumptions. Tier II EPCs were equal to the ProUCL recommended 95%, 97.5%, or 99% upper confidence limit (95% UCL; 97.5% UCL; 99%; UCL) on the mean concentration for all analytes and media where there were sufficient number of detected sample results to perform statistical evaluations. For analytes and media with insufficient detected sample results (e.g., several analytes in upland culturally significant vegetation), the EPC was equal to the maximum detected concentration. The RME assumptions for adult residents were based on standard default values published in IDEQ's *Risk Evaluation Manual* (IDEQ, 2004a), USEPA's *Exposure Factors Handbook* (USEPA, 1997b; 2011), or other published sources. The CTE assumptions for adult residents was based on geometric mean or 50% of RME values obtained from USEPA (USEPA, 1997b; 2011), IDEQ (IDEQ, 2004a), other published sources, or Site-specific information (e.g. local dietary surveys, as available, or professional judgment). Presentation of both RME-based and CTE-based results in the Tier II HHRA provides a range of carcinogenic risk and noncarcinogenic hazard estimates to assist risk managers in making informed risk management decisions for the Henry Site. All RME and CTE exposure parameters for all human receptors are presented in **Table A3-7**.

In addition to Henry Site risks and hazards, the Tier II HHRA included calculation of background risks and hazards for metals that were retained as COPCs following the Tier I screening HHRA. Tier II background cancer risk and noncancer hazard estimates were calculated based on upper-bound average EPCs and RME exposure assumptions. The Tier II HHRA also included the calculation of RME-based incremental risk and hazard estimates, defined as the difference between the risk and hazard estimates for the Henry Site and the risk and hazard estimates for background sampling locations, respectively, for each COPC. COPC-specific incremental risk and hazard estimates are summed to cumulative incremental risk and hazard estimates, respectively, for each medium and receptor.

The general framework for conducting a baseline HHRA is provided in *RAGS Volume I: Human Health Evaluation Manual, Part A* (USEPA, 1989). Consistent with this guidance document, the HHRA consists of the following five steps:

1. Exposure assessment
2. Exposure quantification
3. Toxicity assessment
4. Risk characterization
5. Uncertainty analysis

The first four steps are described in the following sections, as they relate to the human health portion of the BRA. Step 5 was combined into one human health, ecological, and livestock risk assessment uncertainty analysis for the Henry Site, and is presented and discussed in Section 6.0 of this BRA Report.

3.3.1 Exposure Assessment

The exposure assessment portion of the HHRA includes the development of a site-specific CSM that identifies current and anticipated future land uses, potential site-related receptors, and potentially complete and incomplete exposure pathways between human receptors and site-related contaminants. The human health CSM for the Henry Site is described in the following sections, and presented graphically in **Figure A3-1**.

As described in Section 2.1 of the *RI/FS Work Plan*, the primary sources of trace mineral contaminants (i.e., primarily inorganic elements) associated with the Henry Mine include reclaimed mine waste rock dumps and mine pits. A more detailed description of the mobilization and transport of trace minerals from native materials and waste rock is provided in Sections 3.6 and 3.7 of the *RI/FS Work Plan*. In general, physical (wind, precipitation, and ambient temperature changes) and chemical weathering processes at the Henry Mine release trace minerals from waste rock in the mine dumps and other more minor sources. The dissolution of soluble minerals and the oxidation of the surface and in some cases the interior of the waste rock dumps and mine pits are the primary chemical processes affecting the release of chemicals from these areas. Once the waste rock is broken down by physical and chemical processes, trace minerals may be leached into waste rock and soil pore water. Surface and subsurface soils (e.g., waste rock) may be considered secondary sources of contamination (refer to **Figure A3-1**). Secondary release mechanisms include wind erosion of exposed rock and surface soils, surface water runoff, and infiltration of surface water into soils followed by percolation of pore water into groundwater. Tertiary sources of contamination include the following abiotic exposure media: ambient air, surface and subsurface soils, sediment, surface water, and groundwater (**Figure A3-1**).

Key elements of the human health CSM for the Henry Site, including land uses in and around the Site, relevant current and future human receptors, and potentially complete and incomplete exposure pathways between human receptors and contaminated media, are discussed in the following subsections.

3.3.1.1 Land Uses

The Henry Site is located in the SE Idaho Phosphate Resource Area and is an amalgamation of ownership types, including lands privately held by P4 and lands formerly leased from the BLM and the State of Idaho for the purpose of mining. The adjoining or neighboring lands are privately-held ranches and public lands including BLM and State of Idaho lands. Portions of the Henry Site are currently used for livestock grazing. Neighboring lands may be used for recreation and ranching, including grazing of livestock.

3.3.1.2 Current and Future Receptors

In the vicinity of and at the Henry Site, the most common land uses are phosphate mining and livestock grazing. Consequently, current and anticipated future human receptors in these areas include mine site workers and seasonal ranchers. However, mine site workers are protected by Mining Safety and Health Administration (MSHA) regulations and other health and safety rules. As a result, mine site workers were not addressed further in this HHRA for the Henry Site. A rancher would make occasional visits to the Henry Site during summer months to check on cattle that seasonally graze in the vicinity of or at the Henry Site.

State, BLM, and non-P4 private lands in the vicinity of the Henry Site are potentially used by recreational receptors. Current and future recreational receptors include fisherman, hunters, campers and hikers. These receptors potentially come into contact with contaminated abiotic media (e.g., soil, surface water, or sediment) and may consume tissues of harvested biota (e.g., large game animals, including deer and elk, and fish). Additionally, according to the Bridger Treaty between the U.S. Government and Shoshone and Bannock Tribes, current and future Native American receptors have rights to hunt, fish, gather plants, and practice other traditional land uses on unoccupied federal lands. A review of the USEPA's Exposure Factors Handbook (USEPA, 1997) indicates that only about 1% of inhabitants in the Western U.S. consume wild game, and less than 1% (i.e., 0.6%) of Native Americans consumes wild game. Because the percentage of the population consuming game is small, limited data are available to determine ingestion rates, and the harvesting and consumption of game quantitatively evaluated in the HHRA focused on one species of game animal (i.e., elk) only.

Under a hypothetical future use scenario, there are several possible land uses including:

- Private lands within the Henry Site could be developed for residential use.
- Public lands within the Henry Site could be reopened as parks or open space for unrestricted public (primarily recreational) use.
- Seasonal ranchers also could convert their private property into rural residential land use if it was developed, zoned, and approved accordingly.

While future residential land use is unlikely in the vicinity of and for the majority of the Henry Site, a residential receptor was evaluated for purposes of evaluating potential risks under hypothetical future unrestricted land use, and to assist in the development of land use management plans.

Consistent with the current and future land uses discussed above, current and future human receptors appropriate for evaluation in the HHRA for the Henry Site include:

- Current/future Native American
- Hypothetical future resident
- Current/future seasonal rancher
- Current/future recreational hunter
- Current/future recreational camper/hiker
- Current/future recreational fisher

In addition to the above receptors, potential future use of the Henry Site as parkland could result in potential exposures to future park employees. A future worker is anticipated to have lower exposures and risks than the six receptors above, and risk estimates for the six receptors are anticipated to be protective of a future worker.

It is also possible that some exposure pathways could be applicable to multiple receptors. For example, a current/future recreational hunter could also camp or hike; a current/future recreational camper/hiker could hunt; a current/future seasonal rancher could also hunt. Such alternative exposure pathways were evaluated qualitatively in the Uncertainty Analysis, Section 6.0 of this BRA.

3.3.1.3 Complete and Incomplete Exposure Pathways

The human receptors identified in Section 3.3.1.2 are potentially exposed to Site-derived contaminants during various activities. Current/future recreational hunters and current/future Native Americans may use lands for harvesting wild game including upland birds, small game, and large game such as deer and elk. As described above, the consumption of birds and small game harvested from the P4 Sites would contribute a negligible amount to total contaminant intake relative to other potential exposure pathways. Therefore, harvesting and consumption of small game by hunters was not quantitatively evaluated in the HHRA. Current/future Native Americans and recreational fishers, and hypothetical future residents may use the Henry Site for fishing. However, only for those stream sections or ponds that contain water throughout the year and support game fish of sufficient size to be caught and consumed will this pathway be considered complete. Rapid bioassessment protocol (RBP) stream surveys were implemented for flowing waters near the Henry Site to characterize the aquatic habitat quality. As presented in Section 4.6 of the Henry Site RI Report, attempts were made in 2004 to collect fish from Henry area streams. Of the 20 Site and regional background stations evaluated near the Henry Site, 50% are confirmed, or likely based on corroborating higher RBP scores, to have fish present (**Table A4-9**). Therefore, exposure to fish was evaluated for applicable surface water bodies in the Henry Site area. Current/future Native American receptors may also use the Henry Site while gathering culturally significant plants for traditional and cultural purposes, including plants from both perennial and intermittent aquatic environments. A list of the culturally significant plants that were sampled at Henry Site is included in **Table A2-2**. The upland plant data were classified as representative of culturally significant or non-culturally significant species based on a list of culturally significant plants provided by the Agencies and Shoshone-Bannock Tribes. Current/future hikers and campers may use the Henry Site for hiking and camping on short recreational trips. Longer-term activities include potential future residents and seasonal ranchers who could live at, or in the vicinity of, the Henry

Site. These receptors may use groundwater for drinking, cooking, or bathing. The hypothetical future residents may also use groundwater for irrigating fruits and vegetables that are subsequently consumed, and seasonal ranchers may use groundwater for watering livestock.

Complete and incomplete exposure pathways for the above receptors are graphically illustrated in **Figure A3-1**, and described on a medium-specific basis in the following subsections.

Soil. Contaminants may be released to soil through weathering/leaching and dispersion of air-born particulates from waste rock dumps. Human receptors with a potential for exposure to soil at the Henry Site include current/future Native Americans, hypothetical future residents, current/future seasonal ranchers, current/future recreational hunters, current/future recreational hikers/campers, and current/future recreational fishers.

These receptors are potentially exposed to contaminants in soil through direct contact pathways including incidental ingestion and dermal absorption of soil, or inhalation of fugitive dust particles (e.g., generated from physical disturbance of the soil by wind or vehicle traffic). Indirect exposure pathways include consumption of plants grown in contaminated soils, and consumption of livestock or game animals foraging on or around the Henry Site. Exposure to constituents in soil for the current/future recreational hunter, current/future camper/hiker, and current/future seasonal rancher was evaluated quantitatively for upland soil only as these receptors are not expected to spend a significant amount of time near surface water. Exposure to constituents in soil for the current/future Native American and hypothetical future resident was evaluated quantitatively for both upland soil and riparian soil. The current / future recreational fisher was evaluated for exposure to riparian soil only. Both current/future Native Americans and current/future recreational hunters have a complete exposure pathway through the consumption of game animals that may potentially bioaccumulate contaminants from soils at the Henry Site. Current/future Native Americans also may utilize or consume culturally significant plants that grow on or around the Henry Site, and hypothetical future residents may consume fruits and vegetables grown in contaminated soils. The current/future seasonal rancher has potential exposure to soil-derived contaminants through consumption of beef from cattle grazing on or around the Henry Site.

As noted in Section 3.3.1.2, above, it is possible that some terrestrial biota consumption pathways could be applicable to receptors not specifically mentioned above. For example, a recreational camper/hiker could also fish or hunt. Such alternative exposure pathways were evaluated qualitatively in the Uncertainty in Risk Assessments, Section 6.0 of this BRA.

Sediment. Contaminants may be released to sediments through weathering/leaching processes from mine dump materials, infiltration/percolation, and surface water runoff to on-Site ponds and on-Site/off-Site drainages. Direct exposure to contaminants in sediment is potentially complete but insignificant for the current/future Native American, hypothetical future resident, and current/future recreational fisher.

Indirect human exposure to sediment at the Henry Site through the consumption of organisms that uptake contaminants from drainage sediments is a complete exposure pathway for the current/future Native American, hypothetical future resident, and current/future recreational fisher. Consumption of fish is a complete exposure pathway for all three receptors; consumption of culturally significant aquatic plants is a complete exposure pathway for current/future Native Americans. Aquatic plant tissue concentrations were modeled from sediment concentrations for both sediment and surface water COPCs. Fish tissue concentrations were modeled from surface water for both sediment and surface water COPCs where surface water data were available; if no surface water data were available, sediment data were used to model fish tissue concentrations.

Surface Water. Contaminants may be released to surface water through weathering/leaching of mine dump materials, infiltration/percolation, and surface water runoff to on-site ponds and on-Site/off-Site drainages. Surface water exposure pathways are complete for the current/future Native American, hypothetical future resident, current/future recreational hunter, current/future seasonal rancher, and current/future recreational fisher.

Complete exposure pathways include both direct and indirect exposures to contaminants in surface water. Direct exposure pathways include incidental ingestion and dermal contact, and are complete for current/future Native Americans, hypothetical future residents, and current / future recreational fishers because these receptors may be in close proximity to surface water while fishing, or, for the Native American, while gathering culturally significant aquatic plants. It is unlikely that recreational swimming is a significant exposure pathway due to low surface water temperatures, and as a result, direct surface water exposure pathways are potentially complete but insignificant for current/future recreational camper/hiker. Seasonal ranchers may have limited direct contact with surface water, but such exposures are unlikely to be significant. Inhalation of contaminants from surface water is considered to be an incomplete exposure pathway for all receptors because trace metals are not volatile.

Indirect exposure pathways for surface water at the Henry Site include bioaccumulation in aquatic and terrestrial biota, and subsequent harvest by human receptors. Contaminant uptake from surface water to fish represents a potentially complete exposure pathway for current/future Native Americans, hypothetical future residents, and current / future recreational fishers. Contaminant uptake from surface water to large wild game represents a potentially complete exposure pathway for current/future Native Americans and current/future recreational hunters. Surface water may also be used for watering cattle and other livestock, which are subsequently consumed by current/future seasonal ranchers. Consumption of large game and livestock is a potentially complete but insignificant pathway for hypothetical future residents. Consumption of culturally significant aquatic plants is a potentially complete exposure pathway for current/future Native Americans, however, as noted above, aquatic plant concentrations were modeled from sediment concentrations.

Groundwater. Contaminants may be released to groundwater through weathering/leaching of overburden material and infiltration/percolation of trace minerals through the vadose zone to subsurface water. Complete human exposure pathways for groundwater at the Henry Site are limited to the hypothetical future resident and the current/future seasonal rancher.

Complete groundwater exposure pathways include both direct and indirect exposures to contaminants in groundwater. Potentially complete direct exposure pathways result from the use of groundwater at or in the vicinity of the Henry Site as a potable water supply. Direct exposure pathways for hypothetical future residents and current/future seasonal ranchers include ingestion of potable water and dermal contact with potable water while bathing or showering.

Indirect exposure pathways include the use of groundwater for watering livestock and homegrown fruits and vegetables. Watering livestock may result in contaminant uptake by livestock including beef cattle that are subsequently consumed by current/future seasonal ranchers. Groundwater used to irrigate homegrown fruits and vegetables may result in contaminant uptake by plants that are harvested and consumed by hypothetical future residents.

Complete Exposure Pathways Summary for Metals. In summary, potentially complete and significant exposure pathways for human receptors are as follows:

- Current/future Native Americans have potentially complete and significant exposure pathways related to direct contact with upland and riparian soil, direct contact with surface water, and consumption of biota including wild game and fish, upland culturally significant plants, riparian culturally significant plants, and culturally significant plants harvested from aquatic environments.
- Hypothetical future residents have potentially complete and significant exposure pathways related to direct contact with upland and riparian soil, direct contact with groundwater used as a potable water supply, direct contact with surface water, consumption of homegrown fruits and vegetables that can uptake contaminants from groundwater and soil, and consumption of fish.
- Current/future seasonal ranchers have potentially complete and significant exposure pathways related to direct contact with upland soil, direct contact with groundwater used as a potable water supply, and consumption of beef cattle that uptake contaminants from soil and surface water or groundwater while grazing at the Henry Site.
- Current/future recreational hunters have potentially complete and significant exposure pathways associated with direct contact with upland soil and consumption of wild game that uptake contaminants from surface water and upland soil.
- Current/future recreational campers/hikers have potentially complete and significant exposure pathways related to direct contact with upland soil.
- Current/future recreational fishers have potentially complete and significant exposure pathways associated with direct contact with riparian soil, direct contact with surface water, and consumption of fish.

It should be noted that year-round direct exposure to contaminated media including soil and surface water in the vicinity of and at the Henry Site does not occur due to seasonal limitations (i.e., snow for approximately six months of the year). As a result, direct exposure pathways between human receptors and these media are limited. Additionally, indirect exposure pathways associated with the harvesting and consumption of wild game are limited by licenses and seasonal availability, along with State regulations regarding harvest quantities. These limitations were addressed in the human health exposure assessment that was used in the evaluation of risks to public health, as further described in the following sections.

Exposure to Radionuclides. In addition to exposures to chemicals in Site media, human receptors may be exposed to radiation from uranium decay products, namely radium-226 in Site media and radon-222 in indoor air. Only the resident is expected to spend a significant amount of time indoors at hypothetical future structures, and therefore only the resident was evaluated for radon-222 exposures. Complete pathways for radiological exposures are summarized as follows:

- Current/future Native Americans have potentially complete and significant exposure pathways related to direct contact with upland soil (i.e., ingestion and inhalation of particulates), external radiation from upland soil, and ingestion of game, culturally significant upland plants, culturally significant plants harvested from aquatic environments, and fish. Exposure pathways related to riparian soil (i.e., ingestion, inhalation of particulates, and external exposure), direct contact pathways related to surface water (i.e., ingestion and immersion), and ingestion of game that have ingested surface water are incomplete because total uranium, and therefore radium-226, is not a COPC in riparian soil or surface water at the Henry Site.

- Hypothetical future residents have potentially complete and significant exposure pathways related to direct contact with upland soil (i.e., ingestion and inhalation of particulates), external radiation from upland soil, ingestion of fruits and vegetables grown in Henry Site soil and fish harvested from Henry Site streams, and inhalation of indoor air. Exposure pathways related to riparian soil (i.e., ingestion, inhalation of particulates, and external exposure), groundwater (i.e., ingestion, immersion, inhalation, and ingestion of groundwater-irrigated fruits and vegetables), and direct contact pathways related to surface water (i.e., ingestion and immersion) are incomplete because total uranium, and therefore radium-226, is not a COPC in riparian soil, surface water, or groundwater at the Henry Site.
- Current/future seasonal ranchers have potentially complete and significant exposure pathways related to direct contact with upland soil (i.e., ingestion and inhalation of particulates), external radiation from upland soil, and ingestion of livestock. Exposure pathways related to groundwater (i.e., ingestion, immersion, inhalation, and ingestion of beef cattle that have consumed groundwater) and surface water (i.e., ingestion of beef cattle that have consumed surface water) are incomplete because total uranium, and therefore radium-226, is not a COPC in surface water or groundwater at the Henry Site.
- Current/future recreational hunters have potentially complete and significant exposure pathways associated with direct upland soil contact (i.e., ingestion and inhalation of particulates), external radiation from upland soil, and ingestion of game. Exposure to radiation in surface water through ingested of game that have consumed surface water is incomplete because total uranium, and therefore radium-226, is not a COPC at the Henry Site.
- Current/future recreational campers/hikers have potentially complete and significant exposure pathways related to direct contact with upland soil (i.e., ingestion and inhalation of particulates) and external radiation from upland soil.
- Current/future recreational fishers have potentially a complete and significant pathway related consumption of fish from Henry Site streams. Potentially complete exposure pathways associated with riparian soil (i.e., ingestion, inhalation of particulates and external radiation) and direct contact pathways for surface water (i.e., ingestion and immersion) are incomplete because total uranium, and therefore radium-226, is not a COPC in riparian soil or surface water at the Henry Site.

3.3.2 Exposure Quantification

The exposure quantification portion of the HHRA describes the methods for estimating exposure doses based on the pathways identified in the exposure assessment (Section 3.3.1). This section presents the methods for calculating EPCs from Site data, the exposure models for calculating pathway-specific exposures, and the methods for selecting the inputs and assumptions that were used in exposure modeling.

3.3.2.1 Exposure Point Concentrations

An EPC describes the level of a constituent in soil, sediment, water, or food to which a receptor is potentially exposed (USEPA, 1989). As such, the EPC serves as the basis for quantifying pathway-specific exposure doses. Calculation of EPCs in Site media was based on both measured concentrations and non-detect results.

Abiotic media sampling results for the Henry Site are based on site investigation activities conducted between 2004 and 2010. Biota (i.e., upland and riparian vegetation) sampling occurred in 2004 and 2009.

When data were insufficient to calculate a 95% UCL on the mean concentration (e.g., less than 5 samples), maximum concentrations of site COPCs were used to quantify exposure doses and risk estimates. For COPCs with sufficient quantity and quality of data, EPCs were estimated as the ProUCL recommended UCL on the mean concentration.

The UCL on the mean concentrations were calculated using USEPA's ProUCL software version 5.0.00 (USEPA, 2013). Recommendations for appropriate distributions and confidence levels (e.g., 95%, 97.5%, or 99%) provided by the program were utilized. If a dataset contained non-detect results, these results were handled as recommended by the program. If the software recommended more than one UCL, the first in the list was used. Additionally, if a higher confidence than 95% UCL was recommended by ProUCL (i.e., a 97.5% or a 99% UCL), the recommended UCL was utilized. Summary statistics and derived 95% UCLs for COPCs and COPECs in applicable media at the Henry Site and background are presented in **Table A3-8 through Table A3-21**. Detailed ProUCL outputs are presented in **Attachment A**.

The biotic media EPCs for which data are unavailable (e.g., aquatic culturally significant plants, riparian and upland plants for some COPCs, and animal and fish tissues) were modeled from abiotic media as described in Section 3.3.2.2. For biotic media with measured concentrations, the EPC based on the measured data was used preferentially over the modeled EPC. Modeled EPCs are presented in the individual human risk calculation tables (**Attachment B** to **Attachment E**) of this BRA Report. As stated in Section 3.3.1.3, fish consumption by Native Americans, hypothetical residents, and recreational fishers was evaluated for surface water locations where fish have been observed or are likely to be present, as described in Section 4.6 of this RI Report. COPC data for surface water locations evaluated in the fish consumption pathway are summarized in **Table A3-12** and **Table A3-13**.

3.3.2.2 Calculating Exposure Doses for Chemicals

This section describes HHRA methods for quantifying chemical exposure doses for human receptors. Radiological exposure and effects modeling is described in Section 3.3.5. As described in Section 3.3.1.3, complete and potentially significant exposure pathways between human receptors and Site-related COPCs include direct contact pathways (i.e., incidental ingestion, dermal contact, and inhalation of particulates and volatiles) and indirect pathways (i.e., consumption of tissues from plants, livestock and game, and fish). The dose equations that were used in the quantification of direct exposure pathways are consistent with USEPA guidance for conducting exposure assessments (USEPA, 1989; 2009b). Indirect exposure pathways were calculated in accordance with the Risk Assessment Information System (RAIS) (RAIS, 2013). **Equation 1** is a generalized dose equation:

(1) $$\text{General Dose } \left(\frac{\text{mg}}{\text{kg}\times\text{d}}\right) = \frac{\text{C}\times\text{IR}\times\text{CF}\times\text{EF}\times\text{ED}}{\text{BW}\times\text{AT}}$$

Where:

C = Concentration of contaminant in a media (milligrams per kilogram [mg/kg], milligrams per liter [mg/L], or milligrams per cubic meter [mg/m^3])
IR = Intake rate (milligrams [mg] /day)
CF = Conversion factor (10^{-6} kilogram [kg]/mg)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (period over which exposure is averaged – days)

The inputs and assumptions for exposure models were based on IDEQ's Risk Evaluation Manual (IDEQ, 2004a). Additional exposure factors and fate and transport information not provided by IDEQ were derived from USEPA guidance (USEPA, 1997b; 2008a; 2011) (**Table A3-7**).

It is appropriate to use site-specific bioavailability data to make adjustments to exposure estimates for site-specific risk assessments, where such data are available. In the absence of reliable site-specific data, the default assumption is that the bioavailability of the chemical is the same in the exposure medium at the site (e.g., soil, water, etc.) as in the exposure medium used to derive the toxicity value. For arsenic, USEPA's Compilation and Review of Data on Relative Bioavailability of Arsenic in Soil recommends using 60% as an upper-end estimate of arsenic bioavailability in soils (USEPA, 2012). No site-specific bioavailability data were obtained for the Henry Site. As a result, the soil ingestion rate in Equation 2 was modified to include a relative bioavailability (RBA) for arsenic in soil of 60%. All other COPCs in all other media were assumed to be 100% bioavailable.

Soil. Equations for quantifying potential exposures of human receptors to COPCs in Henry Site soils through direct exposure pathways are presented below.

Soil Ingestion Pathway:

(2) $$\text{Incidental Ingestion Dose}\left(\frac{\text{mg}}{\text{kg}\times\text{d}}\right) = \frac{C_S \times IR_S \times CF \times EF \times ED \times RBA}{BW \times AT}$$

Where:

C_s = Concentration in soil (mg/kg)
IR_s = Soil ingestion rate (mg/day)
CF = Conversion factor (10^{-6} kg/mg)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
RBA = Relative bioavailability factor (percent)
BW = Body weight (kg)
AT = Averaging time (days)

For Native American, hypothetical future resident, and recreational fisher receptors, **Equation 2** was modified to include an age-adjusted factor that combines the dose assumptions for child and adult receptors in to a single factor that is used in **Equation 3**. This factor incorporates age-specific factors including body weight, ingestion rate and exposure duration, as presented below.

(3) $$\text{Incidental Ingestion Dose}\left(\frac{\text{mg}}{\text{kg}\times\text{d}}\right) = \frac{C_S \times IF_S \times CF \times RBA}{AT}$$

Where:

$$IF_S\left(\frac{\text{mg}}{\text{kg}}\right) = \frac{ED_c \times EF_c \times IR_{sc}}{BW_c} + \frac{ED_a \times EF_a \times IR_{sa}}{BW_a};$$

and

C_s = Concentration in soil (mg/kg)
IF_s = Age-adjusted soil ingestion factor (mg/kg)
CF = Conversion factor (10^{-6} kg/mg)
RBA = Relative bioavailability factor (percent)

AT = Averaging time (days)
ED_a = Adult exposure duration (years)
ED_c = Child exposure duration (years)
EF_a = Adult exposure frequency (days/year)
EF_c = Child exposure frequency (days/year)
IR_{sa} = Adult soil ingestion rate (mg/day)
IR_{sc} = Child soil ingestion rate (mg/day)
BW_a = Adult body weight (kg)
BW_c = Child body weight (kg)

For recreational camper/hiker receptors, the age-adjusted factor was used to combine dose assumptions for child, youth and adult receptors in to a single factor for use in **Equation 4**, as presented below.

$$(4) \qquad \text{Incidental Ingestion Dose} \left(\frac{\text{mg}}{\text{kg} \times \text{d}}\right) = \frac{C_s \times IF_s \times CF \times RBA}{AT}$$

Where:

$$IF_s \left(\frac{\text{mg}}{\text{kg}}\right) = \frac{ED_c \times EF_c \times IR_{sc}}{BW_c} + \frac{ED_y \times EF_y \times IR_{sy}}{BW_y} + \frac{ED_a \times EF_a \times IR_{sa}}{BW_a};$$

and

C_s = Concentration in soil (mg/kg)
IF_s = Age-adjusted soil ingestion factor (mg/kg)
CF = Conversion factor (10^{-6} kg/mg)
RBA = Relative bioavailability factor (percent)
AT = Averaging time (days)
ED_a = Adult exposure duration (years)
ED_c = Child exposure duration (years)
ED_y = Youth exposure duration (years)
EF_a = Adult exposure frequency (days/year)
EF_c = Child exposure frequency (days/year)
EF_y = Youth exposure frequency (days/year)
IR_{sa} = Adult soil ingestion rate (mg/day)
IR_{sc} = Child soil ingestion rate (mg/day)
IR_{sy} = Youth soil ingestion rate (mg/day)
BW_a = Adult body weight (kg)
BW_c = Child body weight (kg)
BW_y = Youth body weight (kg)

Inhalation of Fugitive Dust or Soil Derived Volatiles Pathway:

$$(5) \qquad \text{Inhalation Concentration} \left(\frac{\text{mg}}{\text{m}^3}\right) = \frac{C_s \times \left(\frac{1}{PEF} \text{ or } \frac{1}{VF}\right) \times ET \times EF \times ED}{AT}$$

Where:

C_s = Concentration in soil (mg/kg)
PEF = Particulate emission factor (m^3/kg)

VF = Soil volatilization factor (m^3/kg)
ET = Exposure time (fraction of day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
AT = Averaging time (days)

All inhalation exposure estimates were quantified consistent with USEPA's RAGS Part F, Supplemental Guidance for Inhalation Risk Assessment (USEPA, 2009b). Inhalation intake is based on an exposure concentration, rather than an exposure dose, and therefore no age-adjusted factors were necessary for combined child and adult receptors.

Dermal Absorption Pathway:

(6) $$\text{Dermally Absorbed Dose }\left(\frac{\text{mg}}{\text{kg}\times\text{d}}\right)=\frac{C_s\times AF\times ABS\times SA\times CF\times EF\times ED}{BW\times AT}$$

Where:

C_s = Concentration in soil (mg/kg)
AF = Soil adherence factor (mg/(square centimeters [cm^2]-day))
ABS= Skin absorption factor (unitless)
SA = Skin surface area (cm^2)
CF = Conversion factor (10^{-6} kg/mg)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (days)

For Native American, hypothetical future resident, and recreational fisher receptors, **Equation 6** was modified to include an age-adjusted factor that combines the dose assumptions for child and adult receptors in to a single factor that is used in **Equation 7**. This factor incorporates age-specific factors such as body weight, skin surface area, soil adherence factor, and exposure duration, as presented below.

(7) $$\text{Dermally Absorbed Dose }\left(\frac{\text{mg}}{\text{kg}\times\text{d}}\right)=\frac{C_s\times DF_s\times ABS\times CF}{AT}$$

Where:

$$DF_s\left(\frac{\text{mg}}{\text{kg}}\right)=\frac{ED_c\times EF_c\times SA_{sc}\times AF_c}{BW_c}+\frac{ED_a\times EF_a\times SA_{sa}\times AF_a}{BW_a};$$

and

C_s = Concentration in soil (mg/kg)
DF_s = Age-adjusted soil dermal factor (mg/kg)
ABS= Skin absorption factor (unitless)
CF = Conversion factor (10^{-6} kg/mg)
AT = Averaging time (days)
ED_a = Adult exposure duration (years)
ED_c = Child exposure duration (years)
EF_a = Adult exposure frequency (days/year)
EF_c = Child exposure frequency (days/year)

SA_{sa} = Adult surface area (cm^2)
SA_{sc} = Child surface area (cm^2)
AF_a = Adult skin adherence factor (mg/cm^2-day)
AF_c = Child skin adherence factor (mg/cm^2-day)
BW_a = Adult body weight (kg)
BW_c = Child body weight (kg)

For recreational camper/hiker receptors, the age-adjusted factor was used to combine dose assumptions for child, youth, and adult receptors in to a single factor for use in **Equation 8**, as presented below.

$$(8) \qquad \text{Dermally Absorbed Dose } \left(\frac{mg}{kg \times d}\right) = \frac{C_s \times DF_s \times ABS \times CF}{AT}$$

Where:

$$DF_s\ \left(\frac{mg}{kg}\right) = \frac{ED_c \times EF_c \times SA_{sc} \times AF_c}{BW_c} + \frac{ED_y \times EF_y \times SA_{sy} \times AF_y}{BW_y} + \frac{ED_a \times EF_a \times SA_{sa} \times AF_a}{BW_a};$$

and

C_s = Concentration in soil (mg/kg)
DF_s = Age-adjusted soil dermal factor (mg/kg)
ABS = Skin absorption factor (unitless)
CF = Conversion factor (10^{-6} kg/mg)
AT = Averaging time (days)
ED_a = Adult exposure duration (years)
ED_c = Child exposure duration (years)
ED_y = Youth exposure duration (years)
EF_a = Adult exposure frequency (days/year)
EF_c = Child exposure frequency (days/year)
EF_y = Youth exposure frequency (days/year)
SA_{sa} = Adult surface area (cm^2)
SA_{sc} = Child surface area (cm^2)
SA_{sy} = Youth surface area (cm^2)
AF_a = Adult skin adherence factor (mg/cm^2-day)
AF_c = Child skin adherence factor (mg/cm^2-day)
AF_y = Youth skin adherence factor (mg/cm^2-day)
BW_a = Adult body weight (kg)
BW_c = Child body weight (kg)
BW_y = Youth body weight (kg)

Surface Water. Equations for quantifying potential exposures of human receptors to COPCs in Henry Site surface water through direct exposure pathways are presented below. Direct exposure pathways for surface water are complete for the Native American, recreational fisher, and hypothetical future resident. Therefore, all surface water dose equations include age-adjusted factors that incorporate age-specific factors such as body weight, water contact rate, and exposure duration, as described below.

Incidental Ingestion:

$$\text{(9)} \qquad \text{Incidental Ingestion Dose } \left(\frac{\text{mg}}{\text{kg} \times \text{d}}\right) = \frac{C_{sw} \times IF_{sw}}{AT}$$

Where:

$$IF_{sw}\ \left(\frac{L}{kg}\right) = \frac{ED_c \times EF_c \times IR_{swc}}{BW_c} + \frac{ED_a \times EF_a \times IR_{swa}}{BW_a};$$

and

C_{sw} = Concentration in surface water (mg/L)
IF_{sw} = Age-adjusted surface water ingestion factor (L/kg)
AT = Averaging time (period over which exposure is averaged – days)
ED_a = Adult exposure duration (years)
ED_c = Child exposure duration (years)
EF_a = Adult exposure frequency (days/year)
EF_c = Child exposure frequency (days/year)
IR_{swa}= Adult Ingestion rate (L/day)
IR_{swc}= Child Ingestion rate (L/day)
BW_a= Adult Body weight (kg)
BW_c= Child Body weight (kg)

Dermal Contact:

$$\text{(10)} \qquad \text{Dermally Absorbed Dose } \left(\frac{\text{mg}}{\text{kg} \times \text{d}}\right) = \frac{C_{sw} \times CF \times DF_{sw} \times Kp}{AT}$$

Where:

$$DF_{sw}\ \left(\frac{\text{hour} \times \text{cm}^2}{\text{kg}}\right) = \frac{ED_c \times EF_c \times ET_c \times SA_{swc}}{BW_c} + \frac{ED_a \times EF_a \times ET_a \times SA_{swa}}{BW_a};$$

and

C_{sw} = Concentration in surface water (mg/L)
CF = Conversion factor (10^{-3} L/cm^3)
DF_{sw}= Age-adjusted dermal factor (hour-cm^2/kg)
Kp = dermal permeability constant (centimeter[cm]/hour)
AT = Averaging time (period over which exposure is averaged – days)
ED_a = Adult exposure duration (years)
ED_c = Child exposure duration (years)
EF_a = Adult exposure frequency (days/year)
EF_c = Child exposure frequency (days/year)
ET_a = Adult dermal exposure time (hours/day)
ET_c = Child dermal exposure time (hours/day)
SA_{swa}= Adult skin surface area exposed while wading (cm^2)
SA_{swc}= Child skin surface area exposed while wading (cm^2)
BW_a= Adult body weight (kg)
BW_c= Child body weight (kg)

Groundwater. Equations for quantifying potential exposures of human receptors to COPCs in Henry Site groundwater through direct exposure pathways are presented below.

Ingestion:

(11) $$\text{Ingestion Dose } \left(\frac{\text{mg}}{\text{kg} \times \text{d}}\right) = \frac{C_{gw} \times IR_{gw} \times EF \times ED}{BW \times AT}$$

Where:

C_{gw} = Concentration in groundwater (mg/L)
IR_{gw}= Ingestion rate (L/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (period over which exposure is averaged – days).

For the hypothetical future resident receptor, **Equation 11** was modified to include an age-adjusted factor that combines the dose assumptions for child and adult receptors in to a single factor that is used in **Equation 12**. This factor incorporates age-specific factors such as body weight, water ingestion rate, and exposure duration, as presented below.

(12) $$\text{Ingestion Dose } \left(\frac{\text{mg}}{\text{kg} \times \text{d}}\right) = \frac{C_{gw} \times IF_{gw}}{AT}$$

Where:

$$IF_{gw} \left(\frac{L}{kg}\right) = \frac{ED_c \times EF_c \times IR_{gwc}}{BW_c} + \frac{ED_a \times EF_a \times IR_{gwa}}{BW_a};$$

and

C_{gw} = Concentration in groundwater (mg/L)
IF_{gw} = Age-adjusted surface water ingestion factor (L/kg)
AT = Averaging time (period over which exposure is averaged – days)
ED_a = Adult exposure duration (years)
ED_c = Child exposure duration (years)
EF_a = Adult exposure frequency (days/year)
EF_c = Child exposure frequency (days/year)
IR_{gwa}= Adult Ingestion rate (L/day)
IR_{gwc}= Child Ingestion rate (L/day)
BW_a= Adult Body weight (kg)
BW_c= Child Body weight (kg)

Dermal Contact:

(13) $$\text{Dermally Absorbed Dose } \left(\frac{\text{mg}}{\text{kg} \times \text{d}}\right) = \frac{C_{gw} \times CF \times SA \times Kp \times ET \times EF \times ED}{BW \times AT}$$

Where:

C_{gw} = Concentration in groundwater (mg/L)

CF = Conversion factor (10^{-3} L/cubic centimeters [cm^3])
SA = Skin surface area exposed (cm^2)
Kp = Dermal permeability constant (cm/hour)
ET = Dermal exposure time (hours/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (period over which exposure is averaged – days)

For the hypothetical future resident receptor, **Equation 13** was modified to include an age-adjusted factor that combines dose assumptions for child and adult receptors in to a single factor that is used in **Equation 14**. This factor incorporates age-specific factors such as body weight, skin surface area, dermal permeability constant and exposure duration, as presented below.

$$(14) \qquad \text{Dermally Absorbed Dose } \left(\frac{mg}{kg \times d}\right) = \frac{C_{gw} \times CF \times DF_{gw} \times Kp}{AT}$$

Where:

$$DF_{gw}\ \left(\frac{hour \times cm^2}{kg}\right) = \frac{ED_c \times EF_c \times ET_c \times SA_{gwc}}{BW_c} + \frac{ED_a \times EF_a \times ET_a \times SA_{gwa}}{BW_a};$$

and

C_{gw} = Concentration in groundwater (mg/L)
CF = Conversion factor (10^{-3} L/cm^3)
DF_{gw}= Age-adjusted dermal factor (hour-cm^2/kg)
Kp = dermal permeability constant (cm/hour)
AT = Averaging time (period over which exposure is averaged – days)
ED_a = Adult exposure duration (years)
ED_c = Child exposure duration (years)
EF_a = Adult exposure frequency (days/year)
EF_c = Child exposure frequency (days/year)
ET_a = Adult dermal exposure time (hours/day)
ET_c = Child dermal exposure time (hours/day)
SA_{gwa}= Adult skin surface area (cm^2)
SA_{gwc}= Child skin surface area (cm^2)
BW_a= Adult body weight (kg)
BW_c= Child body weight (kg)

Vegetation. Equations for quantifying potential exposures of human receptors to COPCs in Henry Site vegetation (i.e., homegrown produce and culturally significant plants) are presented below. Plant consumptions pathways are complete for hypothetical future resident and Native American receptors, and therefore the ingestion equation below includes an age-adjusted factor.

$$(15) \qquad \text{Ingestion of plant matter } \left(\frac{mg}{kg \times d}\right) = \frac{C_p \times PF \times CF}{AT}$$

Where:

$$PF\ \left(\frac{mg}{kg}\right) = \frac{ED_c \times EF_c \times IR_{pc}}{BW_c} + \frac{ED_a \times EF_a \times IR_{pa}}{BW_a};$$

and

C_p = Concentration of contaminant in homegrown produce or culturally significant plant (mg/kg wet plant weight)
PF = Age-adjusted plant ingestion rate factor (mg /kg)
CF = Conversion factor (10^{-6} kg/mg)
AT = Averaging time (period over which exposure is averaged – days)
ED_a = Adult exposure duration (years)
ED_c = Child exposure duration (years)
EF_a = Adult exposure frequency (days/year)
EF_c = Child exposure frequency (days/year)
IR_{pa} = Adult plant ingestion rate (mg/day)
IR_{pc} = Child plant ingestion rate (mg /day)
BW_a = Adult body weight (kg)
BW_c = Child body weight (kg)

When Site-specific plant tissue data were available for constituents identified as COPCs in soil, those measured tissue concentrations were preferentially used in dose estimate calculations. When Site-specific plant tissue data were unavailable, plant tissue concentrations were modeled based on uptake from primary media (i.e., soil and sediment). Additionally, for constituents identified as COPCs in groundwater, plant tissue data for the fruits and vegetables pathway for the future resident were equal to either the measured tissue concentration or the tissue concentration modeled from soil if measured tissue data were insufficient or unavailable, plus the tissue concentration modeled from groundwater, to account for future irrigation. Culturally significant plants are assumed to be harvested wild, and plant uptake of COPCs from soil only was considered for the Native American plant consumption pathway. Equations for modeling concentrations of COPCs in plants grown in upland and riparian soil were derived from risk assessment procedures and equations provided in RAIS (RAIS, 2013) and summarized in **Equation 16** (soil to plant uptake) and **Equation 17** (groundwater to plant uptake) below.

(16) $$C_p = C_s \times (BV_{wet} + MLF)$$

Where:

C_p = Total COPC concentration in plant tissue (mg COPC / kg wet plant tissue)
C_s = Total COPC concentration in soil (mg COPC / kg soil)
Bv_{wet} = Soil to plant uptake (dry soil / wet plant weight)
MLF = Plant mass loading factor (mg soil / mg wet plant)

(17) $$C_p = C_{gw} \times \left(Irr_{rup} + Irr_{res} + Irr_{dep}\right)$$

Where:

$$Irr_{rup} = \frac{Ir \times F \times BV_{wet} \times [1 - \exp(-\lambda_B \times t_b)]}{p \times \lambda_B};$$

$$Irr_{res} = \frac{Ir \times F \times MLF \times [1 - \exp(-\lambda_B \times t_b)]}{p \times \lambda_B};$$

$$Irr_{res} = \frac{Ir \times F \times I_f \times T\ [1 - \exp(-\lambda_E \times t_v)]}{Y_v \times \lambda_E};$$

and

C_p = Total COPC concentration in plant tissue (mg COPC/kg wet plant tissue)
C_{gw} = Total COPC concentration in groundwater (mg COPC /L groundwater)
Irr_{rup} = Root uptake from irrigation multiplier (L/kg)
Irr_{res} = Resuspension from irrigation multiplier (L/kg)
Irr_{dep} = Arial deposition from irrigation multiplier (L/kg)
Ir = Irrigation rate (L/m^2-day)
F = Irrigation period (unitless)
Bv_{wet} = wet root uptake multiplier for vegetables (unitless)
λ_B = Effective rate for removal (1/day)
t_b = Long term deposition and buildup (day)
p = Area density for root zone (kg/m^2)
MLF = Plant mass loading factor (unitless)
I_f = Interception fraction (unitless)
T = Translocation factor (unitless)
λ_E = Decay for removal on produce (1/day)
t_v = Above ground exposure time (day)
Y_v = Plant yield (wet) (kg/m^2)

Equation 18 was used to model aquatic culturally significant plants based on uptake from sediment.

$$(18) \qquad C_p = C_{sed} \times BAF_{sed-p} \times CF$$

Where:

C_p = Total COPC concentration in plant tissue (mg COPC/kg wet tissue).
C_{Sed} = Concentration of COPC in sediment (mg COPC/kg dry sediment)
$BAF_{sed\text{-}p}$ = Bioaccumulation factor from sediment to plant tissue (kg dry plant tissue/kg dry sediment) as presented in **Table A4-16**
CF = Conversion factor (0.324 kg dry plant tissue/kg wet plant tissue)

Beef and Elk. The equation for quantifying potential exposures of human receptors to Henry Site COPCs in beef and elk tissues is presented in **Equation 19**, below.

$$(19) \qquad \text{Ingestion of beef and elk tissue } \left(\frac{mg}{kg \times d}\right) = \frac{C_{lm} \times IR_{lm} \times CF \times EF \times ED \times IF}{BW \times AT}$$

Where:

C_{lm} = Concentration of contaminant in large mammal tissues (mg/kg)
IR_{lm} = Ingestion rate of large mammal tissue (mg/day)
CF = Conversion factor (10^{-6} kg/mg)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
IF = Fraction ingested that is Site-related (unitless)
BW = Body weight (kg)
AT = Averaging time (period over which exposure is averaged – days)

For Native American receptors, **Equation 19** was modified to include an age-adjusted factor that combines dose assumptions for child and adult receptors in to a single factor that is used to estimate elk consumption in **Equation 20**. This factor incorporates age-specific factors such as body weight, ingestion rate and exposure duration, as presented below. Beef consumption was evaluated for adult ranchers only, so no age-adjusted dose equation was used in the beef ingestion dose estimate.

$$(20) \qquad \text{Ingestion of elk } \left(\frac{\text{mg}}{\text{kg} \times \text{d}}\right) = \frac{C_e \times \text{EIF} \times \text{CF}}{\text{AT}}$$

Where:

$$\text{EIF } \left(\frac{\text{mg}}{\text{kg}}\right) = \frac{ED_c \times EF_c \times IR_{ec}}{BW_c} + \frac{ED_a \times EF_a \times IR_{ea}}{BW_a};$$

and

- C_e = Concentration of contaminant in elk (mg/kg)
- EIF = Age-adjusted elk ingestion rate factor (mg /kg)
- CF = Conversion factor (10^{-6} kg/mg)
- AT = Averaging time (period over which exposure is averaged – days)
- ED_a = Adult exposure duration (years)
- ED_c = Child exposure duration (years)
- EF_a = Adult exposure frequency (days/year)
- EF_c = Child exposure frequency (days/year)
- IR_{ea} = Adult elk ingestion rate (mg/day)
- IR_{ec} = Child elk ingestion rate (mg /day)
- BW_a = Adult body weight (kg)
- BW_c = Child body weight (kg)

Equations for modeling concentrations of COPCs in beef and elk tissue were derived from risk assessment procedures and calculations provided in RAIS (RAIS, 2013), and presented below. **Equation 21** was used to model concentrations of COPCs in beef and elk tissue from water, and **Equation 22** was used to model concentrations of COPCs in beef and elk tissue from soil. Parameters for modeling COPC concentrations in beef tissue were derived from RAIS (2013), with the exception of the soil to plant MLF, which was set to zero in this HHRA. The default MLF for pasture presented in RAIS is 0.25 grams of soil per gram dry forage, corresponding to a soil intake that is 25 percent of forage intake. In addition to the MLF-based soil-on-plants soil intake rate, RAIS (2013) recommends an incidental ingestion of soil intake rate of 0.39 kg/day. The primary source for this incidental soil intake rate could not be located, however, the recommended rate corresponds to approximately 3.3 percent of forage intake for beef cattle, and is within the range of estimated soil in diet from all sources, including soil on plants, for ungulates presented in Beyer et al. (1994). The document cited by RAIS (2013) as the source for the default MLF for pasture does not provide a basis for the soil-on-plants intake rate corresponding to 25 percent of forage intake. Because the incidental ingestion soil intake rate of 0.39 kg/day in RAIS (2013) is similar to the intake rate of soil from all sources in Beyer et al (1994), and because the default MLF for pasture is highly conservative in that it assumes ¼ kg of soil will be consumed with every kg of dry forage, uncertainty associated with the use of am MLF equal to zero in **Equation 22** is assumed to be low.

$$(21) \qquad C_{tissue} = C_w \times F_{tissue} \times Q_w$$

Where:

C_{tissue} = Total COPC concentration in beef or elk tissue (mg COPC/kg tissue)

C_w = Total COPC concentration in surface water or groundwater (mg COPC/L)
F_{tissue} = Beef or elk transfer factor (day/kg)
Q_w = Beef or elk water intake (L/day)

$$(22) \qquad C_{tissue} = C_s \times F_{tissue} \times \left[\left(Q_p \times f_p \times f_s \times \left(BV_{dry} + MLF \right) \right) + \left(Q_s \times f_p \right) \right]$$

Where:

C_{tissue} = Total COPC concentration in beef or elk tissue (mg COPC/kg wet tissue)
C_s = Total COPC concentration in soil (mg COPC /kg)
F_{tissue} = Beef cattle or elk transfer factor (day/kg)
Q_p = Beef cattle or elk fodder intake (kg/day)
f_p = Fraction of year beef cattle or elk on site (unitless)
f_s = Fraction of beef cattle or elk's food on site (unitless)
Bv_{dry} = soil to plant uptake dry weight (unitless)
MLF = plant mass loading factor (unitless)
Q_s = Beef cattle or elk soil intake (kg/day)

Fish. The equation for quantifying potential exposures of human receptors to Henry Site COPCs in fish tissues is presented in **Equation 23**, below.

$$(23) \qquad \text{Ingestion of fish tissue } \left(\frac{mg}{kg \times d}\right) = \frac{C_f \times IR_f \times CF \times EF \times ED \times IF}{BW \times AT}$$

Where:

C_f = Concentration of contaminant in fish tissues (mg/kg wet tissue)
IR_f = Ingestion rate of fish tissue (mg/day)
CF = Conversion factor (10^{-6} kg/mg)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
IF = Fraction ingested that is Site-related (unitless)
BW = Body weight (kg)
AT = Averaging time (period over which exposure is averaged – days)

For recreational fishers, **Equation 23** was modified to include an age-adjusted factor that combines dose assumptions for child and adult receptors in to a single factor that is used to estimate fish consumption in **Equation 24**. This factor incorporates age-specific factors such as body weight, ingestion rate and exposure duration, as presented below.

$$(24) \qquad \text{Ingestion of fish } \left(\frac{mg}{kg \times d}\right) = \frac{C_f \times FIF \times CF}{AT}$$

Where:

$$FIF \left(\frac{mg}{kg}\right) = \frac{ED_c \times EF_c \times IR_{fc}}{BW_c} + \frac{ED_a \times EF_a \times IR_{fa}}{BW_a};$$

and

C_f = Concentration of contaminant in fish (mg/kg)
FIF = Age-adjusted fish ingestion rate factor (mg /kg)

CF = Conversion factor (10^{-6} kg/mg)
AT = Averaging time (period over which exposure is averaged – days)
ED_a = Adult exposure duration (years)
ED_c = Child exposure duration (years)
EF_a = Adult exposure frequency (days/year)
EF_c = Child exposure frequency (days/year)
IR_{fa} = Adult fish ingestion rate (mg/day)
IR_{fc} = Child fish ingestion rate (mg /day)
BW_a = Adult body weight (kg)
BW_c = Child body weight (kg)

Equations for modeling concentrations of COPCs in fish tissue were derived from risk assessment procedures and equations provided in RAIS (RAIS, 2013), and presented in **Equation 25** below.

$$C_{tissue} = C_w \times BAF_{w\text{-}f} \times CF \quad (25)$$

Where:

C_{tissue} = Total COPC concentration in fish tissue (mg COPC/kg wet tissue)
C_w = Total COPC concentration in surface water (mg COPC/L)
$BAF_{w\text{-}f}$ = Bioaccumulation factor from water to fish tissue (L water/kg wet fish tissue) as presented in **Table A4-16**.
CF = Conversion factor (0.2 kg dry tissue/kg wet tissue)

3.3.3 Toxicity Assessment

This section describes the toxicity assessment methodology that was used in the evaluation of human health risks for the Henry Site. Human health toxicity assessment methods were developed in accordance with USEPA guidance (USEPA, 1989).

The human health toxicity assessment involves a critical review and interpretation of toxicology data from epidemiological, clinical, animal, and in vitro studies. A review of toxicology data ideally determines both the nature of health effects associated with a particular chemical and the probability that a given dose of a chemical could result in an adverse health effect. In accordance with the USEPA's 2003 Directive (USEPA, 2003), the following is the hierarchy of sources for the derivation of toxicity values that were used in the baseline HHRA for the Henry Site:

1. Integrated Risk Information System (IRIS) Database as cited in USEPA's RSL table (USEPA, 2015a)
2. Provisional Peer Reviewed Toxicity Values (PPRTVs) as cited in USEPA's RSL table (USEPA, 2015a)
3. HEAST as cited in USEPA's RSL Table (USEPA, 2015a)
4. Agency for Toxic Substances and Disease Registry (ATSDR) Minimal Risk Levels as cited in USEPA's RSL Table (USEPA, 2015a)
5. California Environmental Protection Agency (CalEPA) toxicity values as cited in USEPA's RSL table (USEPA, 2015a)

The oral toxicity value for uranium recommended in Stalcup (2016), which was incorporated into the USEPA's RSL table in the 2017 update, was used to evaluated ingestion exposures to uranium.

Toxicology information important for quantitative risk assessment of long-term health effects is generally divided into the following two categories:

- Potential for carcinogenic health effects
- Potential for chronic noncarcinogenic, adverse health effects

3.3.3.1 Carcinogenic Effects of COPCs

The carcinogenic slope factor (CSF) is the toxicity value used to quantitatively express the carcinogenic potential of carcinogenic-causing constituents following oral or dermal exposure. The slope factor is expressed in units of the inverse of milligrams per kilogram per day ($[mg/kg\text{-}day]^{-1}$) and represents the carcinogenic risk per unit daily intake of a carcinogenic constituent. The carcinogenic potential of carcinogenic-causing constituents following inhalation exposure is quantified by a unit risk factor (URF). The URF has units of the inverse of micrograms per cubic meter ($[\mu g/m^3]^{-1}$) and represents the carcinogenic risk for a specified air concentration of a carcinogenic constituent. The CSF and URF represent the upper 95 percent confidence interval (95% CI) of the slope of the dose response curve. The 95% CI assures a safety factor to protect the most sensitive receptors.

All carcinogenic toxicity assessments were performed consistent with RAGS Volume I, Part A (USEPA, 1989) for the Henry Site.

3.3.3.2 Noncarcinogenic Effects of COPCs

The reference dose (RfD) is the toxicity value used to quantitatively express the potential for a constituent to produce chronic, noncarcinogenic effects following oral or dermal exposure. The RfD is expressed in units of mg/kg-day and represents a daily intake of contaminant per kilogram of body weight that is not sufficient to cause the threshold effect of concern for the contaminant. The potential for a noncarcinogenic constituent to produce chronic effects following inhalation exposure is quantified by a reference concentration (RfC), in units of milligrams per cubic meter (mg/m^3). The RfC represents the air concentration of a noncarcinogenic constituent that is not sufficient to cause effects. Exposures that are above the RfD or RfC could potentially cause adverse health effects. Confidence in the RfD or RfC is subjective, based on USEPA review groups and the quality of the supporting database. Constituent-specific RfDs and RfCs do not account for the potential effects of constituent mixtures.

RfDs and RfCs are generally based on no observable adverse effect levels (NOAELs) derived from animal studies. When NOAEL values are unavailable, a lowest observable adverse effect level (LOAEL) is generally used. An uncertainty factor (UF) is typically incorporated into the RfD or RfC to reduce the numerical value, resulting in a more conservative toxicity value.

In addition to UFs, modifying factors (MFs) are often used in calculating RfDs and RfCs. A MF ranging from 0 to 10 can be included to reflect a qualitative, professional assessment of additional uncertainties in critical studies and available databases.

All noncarcinogenic toxicity assessments were performed consistent with RAGS Volume I, Part A (USEPA, 1989) for the Henry Site.

3.3.4 Risk Characterization

The Tier II baseline human health risk characterization for the Henry Site integrated results of the exposure and toxicity assessments described in Sections 3.2 and 3.3, respectively, to derive a quantitative and qualitative evaluation of potential risks to current and potential future human receptors. Methods that were used in the characterization of human health risks are described below.

Calculated exposure doses for each COPC identified for a particular medium were used to estimate constituent-specific and cumulative carcinogenic risks; and noncarcinogenic hazard quotients (HQs) and hazard indices (HIs).

The pathway-specific risk of developing cancer from exposure to a carcinogenic constituent is estimated by multiplying the CSF by the exposure dose, or the URF by the concentration (USEPA, 1989) as presented in **Equation 26**, below:

$$(26) \qquad \text{ILCR(unitless)} = \text{CSF (or URF)} \times \text{Dose (or Concentration)}$$

Where:

ILCR	= Incremental lifetime carcinogenic risk (unitless)
CSF	= Carcinogenic slope factor $(\text{mg/kg-day})^{-1}$
URF	= Unit risk factor $(\mu g/m^3)^{-1}$
Concentration	= Exposure concentration ($\mu g/m^3$)
Dose	= Exposure dose (mg/kg-day)

Pathway-specific carcinogenic risks for individual constituents were summed to derive a constituent-specific risk. Carcinogenic risks from multiple COPCs identified for a Site medium are assumed to be additive and were summed to estimate a cumulative ILCR for all carcinogenic Site contaminants for a given medium. Additionally, carcinogenic risks calculated for various Site media were summed, as appropriate, to estimate cumulative ILCRs for each receptor.

The HQ describes the potential for Site COPCs to produce noncarcinogenic effects. The pathway specific HQ is defined as the ratio of the exposure dose to the RfD, or the concentration to the RfC (USEPA, 1989), as presented in **Equation 27**, below:

$$(27) \qquad \text{HQ (unitless)} = \frac{\text{Dose (or Concentration)}}{\text{RfD (or RfC)}}$$

Where:

HQ	= Hazard quotient (unitless)
Concentration	= Exposure concentration (mg/m^3)
Dose	= Exposure dose (mg/kg-day)
RfC	= Reference concentration (mg/m^3)
RfD	= Reference dose (mg/kg-day)

Pathway-specific hazards for individual constituents were summed to derived a constituent-specific HQ. An HQ greater than 1 indicates that the estimated exposure dose for that COPC may not be protective of noncarcinogenic health effects. An HQ of less than 1 suggests that noncarcinogenic health effects should not occur. Individual HQs for Site COPCs were summed to produce a cumulative HI for each medium.

All cumulative medium-specific HI estimates that exceeded 1 in the incremental Tier II RME evaluation were evaluated to determine if the HI was associated with any constituent-specific HQ estimates in excess of 1. In cases where the medium-specific HI exceeds one, but no single constituent-specific HQ exceeds 1, the HI should be re-evaluated based on target organ effects and a maximum target organ-specific HI should be reported, consistent with USEPA risk assessment guidance (USEPA, 1989). For the Henry Site, all media with HIs greater than 1 were associated with constituent-specific HQs greater than 1, and therefore no target organ evaluation was required. Medium-specific HIs were summed, as appropriate, to estimate a cumulative HI for each receptor.

The ILCR and HQ estimate calculations presented in Appendices B through E were performed using the full unrounded value of medium-specific dose estimates or concentrations, although the values presented in Appendices B through E were rounded for display purposes. Media concentrations less than 100 were rounded to three significant figures, and ICLR and HQ estimates less than 10 were rounded to two significant digits. Media concentrations greater than 100, ICLR and HQ estimates greater than 10, and cumulative ILCR and HI estimates were rounded to the nearest whole number.

3.3.5 Radionuclide Exposure and Effects Modeling

Complete and potentially significant exposure pathways between human receptors and Site-related ROPCs were described in Section 3.3.1.3. These pathways include direct contact (i.e., external exposure to radiation, incidental ingestion of contaminated media and inhalation of soil particulates) and indirect exposure (i.e., consumption of tissues from plants, livestock, game, and fish). Medium- and receptor-specific PRGs to evaluate these pathways were generated using the USEPA's Online PRG Calculator (USEPA, 2015d). Exposure assumptions used in the PRG Calculator are presented in **Table A3-7**, with the exceptions noted below, and results of the effects evaluation for radionuclides are summarized in **Appendix B** through **Appendix E**.

- Exposure duration for the recreation camper/hiker: the recreational scenario in the PRG Calculator only includes an adult and child. As a result, no separate youth recreational camper/hiker was evaluated. The RME and CTE adult recreational camper/hiker exposure duration were assumed to be 24 years and 6.4 years, respectively, equal to the sum of adult and youth recreational camper/hiker exposure duration.
- Inhalation rate, cover layer thickness, gamma shielding factor, and slab size: these parameters are not used in the modeling of chemical exposure and are therefore not included in **Table A3-7**. The child and adult defaults of 10 m^3/day and 20 m^3/day in the PRG calculator were used for the inhalation rates. The cover layer thickness was conservatively assumed to be 0 cm, resulting in an outdoor gamma shielding factor of 1 (0% shielding from ionizing radiation). The outdoor soil PRG was used for all receptors, including the hypothetical future resident. The slab size used in PRG calculations was 1,000,000 m^2, which is the available input slab size closest to the Henry Site area.
- Particulate emission factor: the PRG Calculator does not allow for the input of a site-specific PEF. As a result, the default PEF for Boise, Idaho was selected; the value of the PEF for Boise is similar to the value of the PEF used for the chemical risk assessment at Henry Site.
- The PRG calculator does not have an option for calculating exposure associated with consumption of plants derived from sediment. The sediment PRG for evaluation of the ingestion of culturally significant plants pathway was calculated in the soil PRG Calculator with the same parameters as used for upland culturally significant plants, and an MLF of 0.

As described previously, radiological data are only available for upland soil; radionuclide concentrations for surface water and sediment were modeled from total uranium concentrations. The surface water radium-226 concentrations were modeled from total uranium concentrations assuming secular equilibrium between uranium-238 and radium-226, while radium-226 in sediment was modeled from the total uranium concentration in sediment assuming a two to one ratio of radium-226 to uranium-238. The approximate average of the radium-226 to uranium-238 ratios in upland soil from the *On-Site and Background Areas Radiological and Soil Investigation Summary Report* (MWH, 2015) was used as the basis for the sediment ratio; the assumption of secular equilibrium was used for surface water because no data for calculating this ratio exist for water. Uranium-238 activity was calculated from total uranium using a ratio of 0.49 uranium-238 to total uranium (ATSDR, 2013) and a specific activity of natural uranium of 7.1 x 10^5 picoCuries per gram (pCi/g) (49 CFR 173.434). Measured radionuclide data include gamma counts and radon flux for upland soil, which were converted to radium-226 and radon-222 activity as described in MWH (2015).

Radiological exposure pathways were evaluated with radionuclide EPCs and medium- and receptor-specific PRGs according to **Equation 28**, below:

$$(28) \qquad \text{ILCR (unitless)} = \frac{\text{EPC}}{\text{PRG}} \times \text{TR}$$

Where:

ILCR	= Incremental lifetime carcinogenic risk (unitless)
EPC	= Exposure point concentration (pCi/g or picoCuries per liter [pCi/L])
PRG	= Preliminary remediation goal (pCi/g or pCi/L)
TR	= Target risk (unitless)

3.3.6 Background and Incremental Risk and Hazard Calculations

Site-specific background data for metals are available for various abiotic and biotic media including, but not limited to, soil, surface water, groundwater, and terrestrial vegetation. Methods and procedures that were used in the derivation of background EPCs for background data sets are presented in the *Final Background TM (*MWH, 2013). The background dataset for upland soil presented in MWH (2013) was revised to include additional results from samples collected in 2014, and the updated background statistics for upland soil are presented in the *On-Site and Background Areas Radiological and Soil Investigation Summary Report* (MWH, 2015). Background statistics were used to calculate Tier I screening and Tier II baseline background risk estimates for metals and radionuclides that were retained as COPCs and ROPCs using the same process as described in the proceeding sections. Background risk estimates for the Tier I HHRA were calculated using maximum detected concentrations and RME exposure assumptions. Tier I screening background carcinogenic risk and noncarcinogenic hazard estimates were used in a qualitative comparison to total site carcinogenic risk and noncarcinogenic hazard estimates. Tier II baseline HHRA background carcinogenic risk and noncarcinogenic hazard estimates were calculated based on the upper-bound average background concentration and RME exposure assumptions.

Tier II RME incremental risk and hazard estimates were calculated for each medium and receptor at Henry Site by subtracting the Tier II RME ambient carcinogenic risk or noncarcinogenic hazard estimate from the Tier II RME Henry Site carcinogenic risk and noncarcinogenic hazard estimate for each COPC/ROPC. The underlying rationale for calculating incremental risk and hazard estimates for metals and radionuclides in environmental media is that some fraction of the concentration of a metal or radionuclide is naturally occurring. Therefore, an incremental risk or hazard estimate represents that portion of the total risk or hazard (i.e., the risk or hazard for both Henry Site and ambient concentration) that is above natural, baseline conditions.

3.3.7 Acceptable Risks

USEPA currently considers sites with a cumulative carcinogenic risk estimate between 1 x 10^{-6} and 1 x 10^{-4}, and a noncarcinogenic HI of less than 1, to be appropriate for conditional closure (USEPA, 1991b). IDEQ selected a single value to facilitate risk management decisions, and considers a cumulative carcinogenic risk of 1 x 10^{-5} and noncarcinogenic HI of 1 as the point of departure for making risk management decisions concerning a site (IDEQ, 2004a). Pathways for which the cumulative carcinogenic risk and/or noncarcinogenic HI estimates exceeded these IDEQ and USEPA risk and hazard criteria the Henry Site will be proposed for (1) additional data collection to revise the conceptual exposure model and provide more realistic exposure and risk estimates, or (2) evaluation of remedial alternatives. In addition, conditional closure will be considered following an evaluation of Site-specific issues related to future land uses, the technical feasibility of remediation, and related considerations.

3.4 Summary of Human Health Risk Estimates

Human health risk estimates calculated for the Henry Site and background sample locations are summarized in this section. Potential human health risks were estimated for the current/future Native American, hypothetical future resident, current/future seasonal rancher, current/future recreational hunter, current/future recreational camper/hiker, and current/future recreational fisher scenarios. Tier I HHRA risk estimates for the Henry Site and background sample locations, as summarized in Section 3.4.1, were only calculated for the current/future Native American, hypothetical future resident, and current/future seasonal rancher because these receptors are anticipated to have the highest exposures and risks of any receptors evaluated in this HHRA. Tier II CTE-based and RME-based human health risk estimates were calculated for all six human receptors, as summarized in Section 3.4.2. Detailed human health risk estimate calculations for the Henry Site and background sample locations are presented in **Attachment B** through **Attachment E**.

3.4.1 Tier I Risk Estimates

Tier I human health risk estimates for the three human receptors with the highest potential exposure to environmental media at the Henry Site and background sample locations are described below and summarized in **Tables A3-23** through **A3-28**. Constituents with risk and hazard estimates exceeding the acceptable risk criteria described in Section 3.3.7 were identified as Tier I COPCs for further evaluation in the Tier II HHRA, and are listed by media in the following subsections.

3.4.1.1 Tier I Henry Site and Background

Current/Future Native American – Henry Site

Cumulative Tier I RME ILCR and noncancer HI estimates for a current/future Native American across all exposure media at the Henry Site are 4 x 10^{-3} and 101, respectively (**Table A3-23**). The Tier I RME ILCR associated with metals is 6 x 10^{-4}; this cumulative Tier I RME ILCR is associated with arsenic exposures in upland soil, riparian soil, surface water, culturally significant plants harvested from upland and riparian soil and aquatic environments, and fish. The cancer risk associated with radionuclides is 3 x 10^{-3}; this cumulative Tier I RME ILCR is associated with radium-226 and decay product exposures in upland soil and culturally significant plants harvested from upland soil and aquatic environments. The Tier I RME HI for the current/future Native American is attributable to the following exposure pathways and COPCs: upland soil (uranium and vanadium); culturally significant plants harvested from upland soil (antimony, cadmium, cobalt, selenium, and thallium); riparian soil (vanadium); culturally significant plants harvested from riparian soil (antimony, arsenic, cadmium, cobalt, manganese, nickel, selenium, thallium, and vanadium); culturally significant plants harvested from aquatic environments (antimony, arsenic, cadmium, manganese, nickel, selenium, thallium, uranium, vanadium, and zinc); and fish (antimony and thallium).

Based on the Tier I HHRA results, upland soil, riparian soil, surface water, culturally significant plants grown in upland and riparian soil and aquatic environments, and fish exposed to surface water and sediment were further evaluated in a Tier II HHRA for the current/future Native American. No excess risk or hazard was associated with consumption of elk; therefore, this pathway was not carried forward to the Tier II HHRA for the current/future Native American.

Current/Future Native American – Background

Cumulative Tier I RME ILCR and noncancer HI estimates for a current/future Native American across all exposure media at background sample locations are 3×10^{-3} and 163, respectively (**Table A3-24**). The Tier I RME ILCR associated with metals is 2×10^{-3}; this cumulative Tier I RME is associated with arsenic exposures in upland soil, riparian soil, culturally significant plants harvested from upland and riparian soil and aquatic environments, and fish. The cancer risk associated with radionuclides is 2×10^{-3}; this cumulative Tier I RME ILCR is associated with radium-226 and decay product exposures in upland soil and culturally significant plants harvested from upland soil and aquatic environments. The Tier I RME HI for the current/future Native American is attributable to the following exposure pathways and COPCs: upland soil (vanadium); culturally significant plants harvested from upland soil (antimony, arsenic, cadmium, cobalt, manganese, nickel, selenium, thallium, uranium, and vanadium); culturally significant plants harvested from riparian soil (antimony, arsenic, cadmium, cobalt, manganese, and thallium); culturally significant plants harvested from aquatic environments (cadmium); and fish (antimony and thallium).

Hypothetical Future Resident – Henry Site

Cumulative Tier I RME ILCR and noncancer HI estimates for a hypothetical future resident across all exposure media at the Henry Site are 7×10^{-2} and 348, respectively (**Table A3-25**). The Tier I RME ILCR associated with metals is 1×10^{-2}; this cumulative Tier I RME ILCR is associated with arsenic exposures in upland soil, fruits and vegetables irrigated with groundwater and harvested from upland soil, groundwater, and fish. The cancer risk associated with radionuclides is 6×10^{-2}; this cumulative Tier I RME ILCR is associated with radium-226 and decay product exposures in upland soil, and fruits and vegetables harvested from upland soil; and radon-222 in indoor air. The Tier I RME HI for the hypothetical future resident is attributable to the following exposure pathways and COPCs: upland soil (uranium and vanadium); fruits and vegetables harvested from upland soil (antimony, arsenic, cadmium, cobalt, manganese, molybdenum, nickel, selenium, thallium, uranium, and vanadium); groundwater (cobalt, manganese, selenium, and thallium); and fish (antimony and thallium).

Based on the Tier I HHRA results, upland soil, fruits and vegetables irrigated with groundwater and harvested from upland soil, groundwater, fish exposed to surface water and sediment, and indoor air were further evaluated in a Tier II HHRA for the hypothetical future resident. No excess risk or hazard was associated with exposure to riparian soil or surface water; therefore, these pathways were not carried forward to the Tier II HHRA for the hypothetical future resident.

Hypothetical Future Resident – Background

Cumulative Tier I RME ILCR and noncancer HI estimates for a hypothetical future resident across all exposure media at background sample locations are 6 x 10^{-2} and 157, respectively (**Table A3-26**). The Tier I RME ILCR associated with metals is 2 x 10^{-3}; this cumulative Tier I RME ILCR is associated with arsenic exposures in upland soil, fruits and vegetables irrigated with groundwater and harvested from upland soil, groundwater, and fish. The cancer risk associated with radionuclides is 5 x 10^{-2}; this cumulative Tier I RME ILCR is associated with radium-226 and decay product exposures in upland soil and fruits and vegetables harvested from upland soil; and radon-222 in indoor air. The Tier I RME HI for the hypothetical future resident is attributable to the following exposure pathways and COPCs: upland soil (vanadium); fruits and vegetables irrigated with groundwater and harvested from upland soil (antimony, arsenic, cadmium, cobalt, manganese, molybdenum, nickel, selenium, thallium, and vanadium); and fish (antimony and thallium).

Current/Future Seasonal Rancher – Henry Site

Cumulative Tier I RME ILCR and noncancer HI estimates for a current/future seasonal rancher across all exposure media at the Henry Site are 2 x 10^{-3} and 16, respectively (**Table A3-27**). The Tier I RME ILCR associated with metals is 1 x 10^{-4}; this cumulative Tier I RME ILCR is associated with arsenic in upland soil, cattle that have grazed on upland soil and ingested surface water or groundwater, and groundwater. The cancer risk associated with radionuclides is 2 x 10^{-3}; this cumulative Tier I RME ILCR is associated with radium-226 and decay product exposures in upland soil and cattle that have grazed on upland soil. The cumulative Tier I RME HI for the current/future seasonal rancher is attributable to cattle that have grazed on upland soil and ingested surface water or groundwater (cobalt, selenium, and thallium).

Based on the Tier I HHRA results, upland soil, cattle grazed on upland soil with surface water and groundwater as a water source, and groundwater were further evaluated in a Tier II HHRA for the current/future seasonal rancher.

Current/Future Seasonal Rancher - Background

Cumulative Tier I RME ILCR and noncancer HI estimates for a current/future seasonal rancher across all exposure media at background sample locations are 1 x 10^{-3} and 9, respectively (**Table A3-28**). The Tier I RME ILCR associated with metals is 5 x 10^{-5}; this cumulative Tier I RME ILCR is associated with arsenic exposures in upland soil, cattle that have grazed on upland soil and ingested surface water or groundwater, and groundwater. The cancer risk associated with radionuclides is 9 x 10^{-4}; this cumulative Tier I RME ILCR is associated with radium-226 and decay product exposures in upland soil and cattle that have grazed on upland soil. The cumulative Tier I RME HI for the current/future seasonal rancher is attributable to cattle that have grazed on upland soil and ingested surface water or groundwater (cobalt and thallium).

3.4.2 Tier II Risk Estimates (CTE and RME)

COPCs associated with excess risk or hazard in the Tier I HHRA are indicated in **Table A3-29**. Tier II human health CTE and RME risk estimates for human receptors exposed to environmental media at the Henry Site and background locations are described below and summarized in **Tables A3-30** through **A3-41**. As stated in Section 3.3.7, risk and hazard estimates less than IDEQ and USEPA acceptable cancer risk and noncancer hazard criteria of 1 x 10^{-6} (the lower end of the USEPA's risk management range) and 1, respectively, are considered acceptable. Constituents with Tier II RME risk and hazard estimates exceeding these criteria were identified as risk drivers for further evaluation in the RI Report, and are listed by media in the following subsections.

3.4.2.1 Tier II CTE Henry Site

Tier II human health CTE risk estimates for human receptors exposed to environmental media at the Henry Site are described below and summarized in **Tables A3-30** through **A3-35**. Tier II human health CTE risk estimates were not calculated for background locations because CTE risk estimates are presented for informational purposes, only, and Tier II human health RME incremental risk estimates will be used for making risk management decisions regarding the Henry Site.

Current/Future Native American CTE – Henry Site

Cumulative Tier II CTE ILCR and noncancer HI estimates for a current/future Native American across all exposure media at the Henry Site are 7×10^{-5} and 7, respectively (**Table A3-30**). The Tier II CTE ILCR associated with metals is 2×10^{-5}; this cumulative Tier II CTE ILCR is associated with arsenic exposures in upland soil, and culturally significant plants harvested from upland and riparian soil and aquatic environments. The cancer risk associated with radionuclides is 4×10^{-5}; this cumulative Tier II CTE ILCR is associated with radium-226 and decay product exposures in upland soil and culturally significant plants harvested from upland soil and aquatic environments. The Tier II CTE HI for the current/future Native American is attributable to the following exposure pathways and COPCs: culturally significant plants harvested from upland soil (cadmium); and culturally significant plants harvested from aquatic environments (cadmium and selenium).

Hypothetical Future Resident CTE – Henry Site

Cumulative Tier II CTE ILCR and noncancer HI estimates for a hypothetical future resident across all exposure media at the Henry Site are 9×10^{-3} and 7, respectively (**Table A3-31**). The Tier II CTE ILCR associated with metals is 1×10^{-4}; this cumulative Tier II CTE is associated with arsenic exposures in upland soil, fruits and vegetables irrigated with groundwater and harvested from upland soil, and groundwater. The cancer risk associated with radionuclides is 9×10^{-3}; this cumulative Tier II CTE ILCR is associated with radium-226 and decay product exposures in upland soil and fruits and vegetables harvested from upland soil; and radon-222 in indoor air. The Tier II CTE HI for a hypothetical future resident is attributable to the following exposure pathway and COPC: fruits and vegetables irrigated with groundwater and harvested from upland soil (thallium).

Current/Future Seasonal Rancher CTE – Henry Site

Cumulative Tier II CTE ILCR and noncancer HI estimates for a current/future seasonal rancher across all exposure media at the Henry Site are 3×10^{-5} and 2, respectively (**Table A3-32**). The Tier II CTE ILCR associated with metals is 5×10^{-6}; this cumulative Tier II CTE ILCR is associated with arsenic in cattle that have grazed on upland soil and ingested surface water or groundwater. The cancer risk associated with radionuclides is 3×10^{-5}; this cumulative Tier II CTE ILCR is associated with radium-226 and decay product exposures in upland soil. The cumulative Tier II CTE HI for the current/future seasonal rancher is attributable to cattle that have grazed on upland soil and ingested surface water or groundwater (thallium).

Current/Future Recreational Hunter CTE – Henry Site

Cumulative Tier II CTE ILCR and noncancer HI estimates for a current/future recreational hunter across all exposure media at the Henry Site are 7×10^{-6} and 0.008, respectively (**Table A3-33**). The Tier II CTE ILCR associated with metals is 5×10^{-8}, which is below IDEQ's and USEPA's acceptable risk criteria. The cancer risk associated with radionuclides is 7×10^{-6}; this cumulative Tier II CTE ILCR is associated with radium-226 and decay product exposures in upland soil. The Tier II CTE HI is below IDEQ's and USEPA's acceptable hazard criteria.

Current/Future Recreational Camper / Hiker CTE – Henry Site

Cumulative Tier II CTE ILCR and noncancer HI estimates for a current/future recreational camper / hiker across all exposure media at the Henry Site are 4 x 10^{-6} and 0.005, respectively (**Table A3-34**). The Tier II CTE ILCR associated with metals is 4 x 10^{-8}, which is below IDEQ's and USEPA's acceptable risk criteria. The cancer risk associated with radionuclides is 3 x 10^{-6}; this cumulative Tier II CTE ILCR is associated with radium-226 and decay product exposures in upland soil. The Tier II CTE HI is below IDEQ's and USEPA's acceptable hazard criteria.

Current/Future Recreational Fisher CTE – Henry Site

Cumulative Tier II CTE ILCR and noncancer HI estimates for a current/future recreational fisher across all exposure media at the Henry Site are 9 x 10^{-7} and 1, respectively (**Table A3-35**). The Tier II CTE ILCR is associated with metals only; radium-226 risks for the current/future recreational fisher were de minimus in the Tier I risk assessment, and radium-226 was therefore not carried forward to the Tier II risk assessment. This Tier II CTE ILCR is below IDEQ's and USEPA's acceptable risk criteria. The Tier II CTE HI is below IDEQ's and USEPA's acceptable hazard criteria.

3.4.2.2 Tier II Henry Site, Background, and Incremental – RME

Tier II human health RME Henry Site, background, and incremental risk estimates for human receptors are described below and summarized in **Tables A3-36** through **A3-41**.

Current/Future Native American RME – Henry Site

Cumulative Tier II RME ILCR and noncancer HI estimates for a current/future Native American across all exposure media at the Henry Site are 1 x 10^{-3} and 44, respectively (**Table A3-36**). The cumulative Tier II RME ILCR associated with metals is 4 x 10^{-4}; this cumulative Tier II RME ILCR is associated with arsenic exposures in upland soil, riparian soil, surface water, culturally significant plants harvested from upland and riparian soil and aquatic environments, and fish. The cumulative Tier II RME ILCR associated with radionuclides is 7 x 10^{-4}; this cumulative Tier II RME ILCR is associated with radium-226 and decay product exposures in upland soil, and culturally significant plants harvested from upland soil and aquatic environments. The cumulative Tier II RME HI for the current/future Native American is attributable to the following exposure pathways and COPCs: culturally significant plants harvested from upland soil (antimony, cadmium, cobalt, selenium, and thallium); culturally significant plants harvested from riparian soil (antimony, arsenic, cadmium, cobalt, manganese, selenium, thallium, and vanadium); culturally significant plants harvested from aquatic environments (arsenic, cadmium, manganese, selenium, uranium, and zinc); and fish (antimony and thallium).

Current/Future Native American RME – Background

Cumulative Tier II RME ILCR and noncancer HI estimates for a current/future Native American across all exposure media at background sample locations are 1 x 10^{-3} and 139, respectively (**Table A3-36**). The cumulative Tier II RME ILCR associated with metals is 7 x 10^{-4}; this cumulative Tier II RME ILCR is associated with arsenic exposures in upland soil, riparian soil, culturally significant plants harvested from upland and riparian soil and aquatic environments, and fish. The cumulative Tier II RME ILCR associated with radionuclides is 3 x 10^{-4}; this cumulative Tier II RME ILCR is associated with radium-226 and decay product exposures in upland soil, and culturally significant plants harvested from upland soil and aquatic environments. The cumulative Tier II RME HI for the current/future Native American is attributable to the following exposure pathways and COPCs: culturally significant plants harvested from upland soil (antimony, arsenic, cadmium, cobalt, and thallium); culturally significant plants harvested from riparian soil (antimony, arsenic, cobalt, manganese, and thallium); culturally significant plants harvested from aquatic environments (cadmium); and fish (antimony and thallium).

Current/Future Native American RME – Incremental

Cumulative incremental Tier II RME ILCR and noncancer HI estimates for a current/future Native American across all exposure media at the Henry Site are 6×10^{-4} and 26, respectively (**Table A3-36**). The cumulative incremental Tier II RME ILCR associated with metals is 2×10^{-4}; this cumulative incremental Tier II RME ILCR is associated with arsenic exposures in upland soil, surface water, and culturally significant plants harvested from aquatic environments. The cumulative incremental Tier II RME ILCR associated with radionuclides is 4×10^{-4}; this cumulative incremental Tier II RME ILCR is associated with radium-226 and decay product exposures in upland soil, and culturally significant plants harvested from upland soil and aquatic environments. The cumulative incremental Tier II RME HI for the current/future Native American is attributable to the following exposure pathways and COPCs: culturally significant plants harvested from upland soil (selenium); culturally significant plants harvested from riparian soil (selenium and vanadium); and culturally significant plants harvested from aquatic environments (cadmium, selenium, uranium, and zinc).

Hypothetical Future Resident RME – Henry Site

Cumulative Tier II RME ILCR and noncancer HI estimates for a hypothetical future resident across all exposure media at the Henry Site are 4×10^{-2} and 97, respectively (**Table A3-37**). The cumulative Tier II RME ILCR associated with metals is 2×10^{-3}; this cumulative Tier II RME is associated with arsenic exposures in upland soil, fruits and vegetables irrigated with groundwater and harvested from upland soil, groundwater, and fish. The cumulative Tier II RME ILCR associated with radionuclides is 3×10^{-2}; this cumulative Tier II RME ILCR is associated with radium-226 and decay product exposures in upland soil, and fruits and vegetables harvested from upland soil; and radon-222 in indoor air. The cumulative Tier II RME HI for a hypothetical future resident is attributable to the following exposure pathways and COPCs: fruits and vegetables irrigated with groundwater and harvested from upland soil (antimony, arsenic, cadmium, cobalt, molybdenum, selenium, uranium, and thallium); groundwater (cobalt and thallium); and fish (antimony and thallium).

Hypothetical Future Resident RME – Background

Cumulative Tier II RME ILCR and noncancer HI estimates for a hypothetical future resident across all exposure media at background sample locations are 2×10^{-2} and 126, respectively (**Table A3-37**). The cumulative Tier II RME ILCR associated with metals is 7×10^{-4}; this cumulative Tier II RME ILCR is associated with arsenic exposures in upland soil, fruits and vegetables irrigated with groundwater and harvested from upland soil, groundwater, and fish. The cumulative Tier II RME ILCR associated with radionuclides is 2×10^{-2}; this cumulative Tier II RME ILCR is associated with radium-226 and decay product exposures in upland soil and fruits and vegetables harvested from upland soil; and radon-222 in indoor air. The cumulative Tier II RME HI for a hypothetical future resident is attributable to the following exposure pathways and COPCs: fruits and vegetables irrigated with groundwater and harvested from upland soil (antimony, arsenic, cobalt, molybdenum, and thallium) and fish (antimony and thallium).

Hypothetical Future Resident RME – Incremental

Cumulative incremental Tier II RME ILCR and noncancer HI estimates for a hypothetical future resident across all exposure media at the Henry Site are 2×10^{-2} and 69, respectively (**Table A3-37**). The cumulative incremental Tier II RME ILCR associated with metals is 1 x 10^{-3}; this cumulative incremental Tier II RME ILCR is associated with arsenic exposures in upland soil, fruits and vegetables irrigated with groundwater and harvested from upland soil, and groundwater. The cumulative incremental Tier II RME ILCR associated with radionuclides is 2 x 10^{-2}; this cumulative incremental Tier II RME ILCR is associated with radium-226 and decay product exposures in upland soil and fruits and vegetables harvested from upland soil; and radon-222 in indoor air. The cumulative incremental Tier II RME HI for a hypothetical future resident is attributable to the following exposure pathways and COPCs: fruits and vegetables irrigated with groundwater and harvested from upland soil (arsenic, cadmium, molybdenum, selenium, and thallium); and groundwater (cobalt and thallium).

Current/Future Seasonal Rancher RME – Henry Site

Cumulative Tier II RME ILCR and noncancer HI estimates for a current/future seasonal rancher across all exposure media at the Henry Site are 5 x 10^{-4} and 7, respectively (**Table A3-38**). The cumulative Tier II RME ILCR associated with metals is 7 x 10^{-5}; this cumulative Tier II RME ILCR is associated with arsenic in upland soil, cattle that have grazed on upland soil and ingested surface water or groundwater, and groundwater. The cumulative Tier II RME ILCR associated with radionuclides is 4 x 10^{-4}; this cumulative Tier II RME ILCR is associated with radium-226 and decay product exposures in upland soil and cattle that have grazed on upland soil. The cumulative Tier II RME HI for the current/future seasonal rancher is attributable to cattle that have grazed on upland soil and ingested surface water or groundwater (thallium).

Current/Future Seasonal Rancher RME – Background

Cumulative Tier II RME ILCR and noncancer HI estimates for a current/future seasonal rancher across all exposure media at background sample locations are 2 x 10^{-4} and 3, respectively (**Table A3-38**). The cumulative Tier II RME ILCR associated with metals is 2 x 10^{-5}; this cumulative Tier II RME ILCR is associated with arsenic exposures in upland soil, cattle that have grazed on upland soil and ingested surface water or groundwater, and groundwater. The cumulative Tier II RME ILCR associated with radionuclides is 2 x 10^{-4}; this cumulative Tier II RME ILCR in excess of IDEQ's and USEPA's acceptable risk criteria is associated with radium-226 and decay product exposures in upland soil and cattle that have grazed on upland soil. The cumulative Tier II RME HI for the current/future Native American is attributable to cattle that have grazed on upland soil and ingested surface water or groundwater (thallium).

Current/Future Seasonal Rancher RME – Incremental

Cumulative incremental Tier II RME ILCR and noncancer HI estimates for a current/future seasonal rancher across all exposure media at the Henry Site are 3 x 10^{-4} and 4, respectively (**Table A3-38**). The cumulative incremental Tier II RME ILCR associated with metals is 5 x 10^{-5}; this cumulative incremental Tier II RME ILCR is associated with arsenic in upland soil, cattle that have grazed on upland soil and ingested surface water or groundwater, and groundwater. The cumulative incremental Tier II RME ILCR associated with radionuclides is 3 x 10^{-4}; this cumulative incremental Tier II RME ILCR is associated with radium-226 and decay product exposures in upland soil and cattle that have grazed on upland soil. The cumulative incremental Tier II RME HI for the current/future seasonal rancher is attributable to cattle that have grazed on upland soil and ingested surface water or groundwater (thallium).

Current/Future Recreational Hunter RME – Henry Site

Cumulative Tier II RME ILCR and noncancer HI estimates for a current/future recreational hunter across all exposure media at the Henry Site are 1 x 10^{-4} and 0.04, respectively (**Table A3-39**). The cumulative Tier II RME ILCR associated with metals is 8 x 10^{-7}, which is below IDEQ's and USEPA's acceptable risk criteria. The cumulative Tier II RME ILCR associated with radionuclides is 1 x 10^{-4}; this cumulative Tier II RME ILCR is associated with radium-226 and decay product exposures in upland soil. The cumulative Tier II RME HI is below IDEQ's and USEPA's acceptable hazard criteria.

Current/Future Recreational Hunter RME – Background

Cumulative Tier II RME ILCR and noncancer HI estimates for a current/future recreational hunter across all exposure media at background sampling locations are 4 x 10^{-5} and 0.01, respectively (**Table A3-39**). The cumulative Tier II RME ILCR associated with metals is 3 x 10^{-7}, which is below IDEQ's and USEPA's acceptable risk criteria. The cumulative Tier II RME ILCR associated with radionuclides is 4 x 10^{-5}; this cumulative Tier II RME ILCR is associated with radium-226 and decay product exposures in upland soil. The cumulative Tier II RME HI is below IDEQ's and USEPA's acceptable hazard criteria.

Current/Future Recreational Hunter RME – Incremental

Cumulative incremental Tier II RME ILCR and noncancer HI estimates for a current/future recreational hunter across all exposure media at the Henry Site are 6 x 10^{-5} and 0.02, respectively (**Table A3-39**). The cumulative incremental Tier II RME ILCR associated with metals is 5 x 10^{-7}, which is below IDEQ's and USEPA's acceptable risk criteria. The cumulative incremental Tier II RME ILCR associated with radionuclides is 6 x 10^{-5}; this cumulative incremental Tier II RME ILCR is associated with radium-226 and decay product exposures in upland soil. The cumulative incremental Tier II RME HI is below IDEQ's and USEPA's acceptable hazard criteria.

Current/Future Recreational Camper/Hiker RME – Henry Site

Cumulative Tier II RME ILCR and noncancer HI estimates for a current/future recreational camper/hiker across all exposure media at the Henry Site are 6 x 10^{-5} and 0.04, respectively (**Table A3-40**). The cumulative Tier II RME ILCR associated with metals is 1 x 10^{-6}, which does not exceed IDEQ's and USEPA's acceptable risk criteria. The cumulative Tier II RME ILCR associated with radionuclides is 6 x 10^{-5}; this cumulative Tier II RME ILCR is associated with radium-226 and decay product exposures in upland soil. The cumulative Tier II RME HI is below IDEQ's and USEPA's acceptable hazard criteria.

Current/Future Recreational Camper/Hiker RME – Background

Cumulative Tier II RME ILCR and noncancer HI estimates for a current/future recreational camper/hiker across all exposure media at background sampling locations are 2 x 10^{-5} and 0.01, respectively (**Table A3-40**). The cumulative Tier II RME ILCR associated with metals is 4 x 10^{-7}, which is below IDEQ's and USEPA's acceptable risk criteria. The cumulative Tier II RME ILCR associated with radionuclides is 2 x 10^{-5}; this cumulative Tier II RME ILCR is associated with radium-226 and decay product exposures in upland soil. The cumulative Tier II RME HI is below IDEQ's and USEPA's acceptable hazard criteria.

Current/Future Recreational Camper/Hiker RME – Incremental

Cumulative incremental Tier II RME ILCR and noncancer HI estimates for a current/future recreational camper/hiker across all exposure media at the Henry Site are 4 x 10^{-5} and 0.03, respectively (**Table A3-40**). The cumulative incremental Tier II RME ILCR associated with metals is 8 x 10^{-7}, which does not exceed IDEQ's and USEPA's acceptable risk criteria. The cumulative incremental Tier II RME ILCR associated with radionuclides is 4 x 10^{-5}; this cumulative incremental Tier II RME ILCR is associated with radium-226 and decay product exposures in upland soil. The cumulative incremental Tier II RME HI is below IDEQ's and USEPA's acceptable hazard criteria.

Current/Future Recreational Fisher RME – Henry Site

Cumulative Tier II RME ILCR and noncancer HI estimates for a current/future recreational fisher across all exposure media at the Henry Site are 3 x 10^{-5} and 12, respectively (**Table A3-41**). The cumulative Tier II RME ILCR is associated with metals only; radium-226 risks for the current/future recreational fisher were de minimus in the Tier I risk assessment, and radium-226 was therefore not carried forward to the Tier II risk assessment. This cumulative Tier II RME ILCR is associated with arsenic exposures in fish. The cumulative Tier II RME HI for current/future recreational fisher is attributable to fish (antimony and thallium).

Current/Future Recreational Fisher RME – Background

Cumulative Tier II RME ILCR and noncancer HI estimates for a current/future recreational fisher across all exposure media at background sampling locations are 3 x 10^{-5} and 83, respectively (**Table A3-41**). This cumulative Tier II RME ILCR is associated with arsenic exposures in fish; as described above, radionuclides were not evaluated for the recreational fisher in the Tier II HHRA. The cumulative Tier II RME HI for current/future recreational fisher is attributable to fish (antimony and thallium).

Current/Future Recreational Fisher RME – Incremental

Cumulative incremental Tier II RME ILCR and noncancer HI estimates for a current/future recreational fisher across all exposure media at the Henry Site are 6 x 10^{-7} and 0.003, respectively (**Table A3-41**). This cumulative incremental Tier II RME ILCR does not exceed IDEQ's and USEPA's acceptable risk criteria; as described above, the ILCR is for metals only as radionuclides were not evaluated for the recreational fisher in the Tier II HHRA. The cumulative incremental Tier II RME HI is below IDEQ's and USEPA's acceptable hazard criteria.

4.0 ECOLOGICAL RISK ASSESSMENT

The general procedures used in the ecological risk assessment (ERA) for the Henry Site are consistent with procedures defined in USEPA (USEPA, 1997c) and IDEQ (IDEQ, 2004b) guidance, and in consideration of prior regional risk assessments that were conducted for the Southeast Idaho Phosphate Resource Area. As further described in this section, the ERA was structured in a tiered manner with each tier presenting further refinements to the exposure and effects characterization steps used in the preceding tier. The Tier I ERA consists of a conservative, screening-level ERA to identify COPECs, media of concern, and receptors of concern for the Henry Site. The Tier II ERA consists of a Site-specific, baseline ERA that used refined exposure and effects characterization methods.

The ERA methods, assumptions and screening criteria described below are applicable to the preparation of a baseline ERA that evaluates effects of chronic exposures of wildlife to site contaminants.

4.1 COPEC Screening

A screening step was performed to focus the risk assessment on COPECs through a comparison of Site constituent concentrations to media-specific (i.e., soil, surface water, and sediment) screening levels. The Site-specific concentrations used for these comparisons were maximum detected concentrations of each detected constituent in each medium. The semi-quantitative COPEC screening methods and other qualitative tools that were used to select COPECs are discussed in the following subsections.

4.1.1 Screening Levels

Selected ecological screening levels, or benchmarks, representing the lowest medium-specific screening criterion available from the sources reviewed, are presented in **Table A4-1 through Table A4-6**. These screening benchmarks are intended to represent concentrations below which there is minimal probability of ecological impacts. A summary of COPECs for all media are summarized in **Table A4-7**.

4.1.1.1 Soil

The selected screening benchmarks for upland and riparian soil at the Henry Site are presented in **Table A4-1** and **Table A4-2**, respectively. Soil screening criteria were identified for each constituent detected in samples of upland and riparian soil collected at a depth range of 0 to 6 inches bgs. The lowest soil screening benchmarks for mammalian and avian indicator receptors, as well as benchmarks for lower trophic level receptors, were selected from the following preferred sources:

1. USEPA Ecological Soil Screening Levels (EcoSSLs) (USEPA, various dates).
2. Oak Ridge National Laboratory's (ORNL's) Toxicological Benchmarks for plants and terrestrial invertebrates (ORNL1997a; 1997b).

Benchmarks for upper trophic level receptors were selected as the lower of the soil benchmark for avian or mammalian receptors presented in USEPA's EcoSSLs (USEPA, various dates). Benchmarks for lower trophic level receptors were selected as the lowest of the soil benchmarks for plants or soil invertebrates presented in USEPA's EcoSSLs (USEPA, various dates), for terrestrial plants benchmark (ORNL, 1997a), or for soil microbes or soil invertebrates (ORNL, 1997b). Detected constituents were also identified as COPECs if screening benchmark were unavailable.

4.1.1.2 Surface Water

Surface water samples were collected from upstream and downstream of the Henry Site, and from Henry Site ponds; water hardness, and therefore hardness-dependent surface water screening benchmarks, varied between these three surface water sampling areas. Surface water screening benchmarks for constituents detected in upstream surface water, downstream surface water, and pond surface water at the Henry Site are presented in **Table A4-3**, **Table A4-4** and **Table A4-5**, respectively. The final list of COPECs for surface water includes COPECs identified for one or more of the three areas. Screening criteria were selected from available surface water benchmarks derived from the following preferred hierarchy:

1. State of Idaho surface water quality criteria (IDAPA 58.01.02); State of Idaho Surface Water Quality for Aquatic Life (IDAPA 58.01.02); Continuous Chronic Criteria (CCC) values or Acute Criterion, criterion maximum concentration (CMC), if CCC values are unavailable (IAC, 2009a).
2. USEPA NRWQC CCC values; or CMC values if CCC values are unavailable (USEPA, 2015b).
3. ORNL toxicological benchmarks for aquatic biota; lowest value of the lowest chronic value (LCV), Tier II secondary chronic value (SCV) or the lowest population effects concentration (EC) 20 (ORNL, 1996a).

The screening criteria for surface water were first selected from State of Idaho benchmarks. If no state benchmark was available for a detected constituent, the criterion was selected from the USEPA NRWQC. Screening criteria for constituents without state or national criteria were selected as the lowest benchmark from ORNL (1996a, 2015b); if no benchmark was available, the constituent was included as a COPEC. The State of Idaho surface water quality criteria and the USEPA NRWQC values for metals with hardness-dependent toxicity (i.e., cadmium, chromium, copper, lead, nickel, silver, and zinc) were adjusted for the Site-specific hardness concentrations measured in upstream, downstream, and pond surface water locations. A water hardness levels of 256 mg/L was used to adjust surface water quality criteria for downstream locations (**Table A4-4**). Hardness at upstream and pond locations exceeded 400 mg/L, so a maximum allowable water hardness of 400 mg/L was used to adjust surface water quality criteria for downstream and pond locations (**Table A4-3** and **Table A4-5**).

The current USEPA NRWQC for selenium are 0.0031 mg/L for lotic systems and 0.0015 mg/L in lentic systems (USEPA, 2016c). The basis for identification of selenium as a COPEC at upstream, downstream, and pond surface water locations in **Table A4-3 through Table A4-5** was comparison of data from those locations to the State of Idaho benchmark for selenium of 0.005 mg/L. Because selenium was identified as a COPEC for surface water at the Henry Site, use of the higher State of Idaho standard over the revised NRWQC for COPEC selection had no material effect on the ERA.

4.1.1.3 Sediment

Sediment screening benchmarks are presented in **Table A4-6**. Sediment benchmarks were obtained from the following preferred source:

1. Freshwater sediment screening benchmarks presented in USEPA's Region 3 Biological Technical Assistance Group (BTAG) (USEPA, 2006b).

If no sediment screening benchmark was available for a detected constituent, that constituent was conservatively considered to be a COPEC.

4.1.2 Other COPEC Screening Tools

Other tools used to determine whether a constituent was retained as a COPEC for evaluation in the tiered-ERA include:

- Essential nutrient status: If a constituent was considered an essential nutrient, it was not carried forward as a COPEC.
- Persistent, bioaccumulative, and toxic (PBT) constituents: Per comments received on the *RI/FS Work Plan*, it was agreed that following the risk screening process, but prior to eliminating a COPEC from further evaluation, a consideration would be made regarding whether the COPEC is potentially bioaccumulative. COPECs identified as potentially bioaccumulative by USEPA (USEPA, 2006b) will be considered as a starting point for this determination. However, the risk screening results along with Site-specific biotic and abiotic data may also be used to support decisions on refining the list of COPECs carried forward into the Tier I and Tier II ERA.

A summary of all COPECs across all media at the Henry Site is presented in **Table A4-7**.

4.2 Tier I and II ERA

Tier I and Tier II ERA procedures described by USEPA under CERCLA (USEPA, 1997c) were used to quantitatively evaluate ecological risks to the ecological assessment endpoints identified in Section 4.2.1.4, below. Similar to the HHRA, risk estimates from the Tier I ERA are termed screening level risk estimates and those from the Tier II ERA are termed baseline risk estimates. The tiered process is intended to focus and refine the risk evaluation by potentially eliminating either COPECs or ecological receptors from the baseline ERA that are insignificant, and by reducing inherent uncertainties in the ERA. Both Tier I and Tier II assessments for the Henry Site used the same methods, but assumptions regarding the potential for exposures and adverse effects to occur were skewed in the Tier I screening to represent the upper bounds of potential exposure concentrations and the lower bounds of potential for adverse effects. Thus, any COPECs or receptors that were eliminated in Tier I were done so with a high degree of certainty that adverse effects will not occur. The specific differences in assumptions between these two Tiers of the ERA are discussed in further detail in Section 4.2.2 (Exposure Analysis) and Section 4.2.3 (Effects Analysis).

The ERA framework consists of four phases: problem formulation, exposure analysis, effects analysis, and the risk characterization (**Figure A4-1**). Problem formulation is the first phase of the process where the problem (i.e., the purpose of the assessment) and the plan for analyzing and characterizing risk are defined. Discussion and planning among risk managers and risk assessors are important components of this phase of the ERA, and typically occur during the work plan stage of the RI/FS process. The second step of the process is the exposure analysis phase in which potential ecological exposures to environmental stressors are quantified. In the third phase of the process, effects analysis, the potential adverse ecological effects from environmental stressors are identified and criteria for quantifying adverse effects are defined. During the fourth phase of the process, risk characterization, the exposure and effects analyses are integrated. In this phase, the likelihood of adverse ecological effects occurring is estimated. Major uncertainties, assumptions, and strengths and limitations of the assessment are also summarized in the risk characterization. The methods that were used for each of the above phases of the ERA for the Henry Site are described in the following subsections.

4.2.1 Problem Formulation

Problem formulation is a formal process for generating and evaluating preliminary hypotheses about the potential for adverse ecological effects to occur. The primary components of problem formulation are:

- Identification of the ecosystem at risk
- Identification of stressor characteristics
- Identification of known effects
- Selection of assessment endpoints
- Construction of a CSM

These components of the problem formulation for the Henry Site are discussed below.

4.2.1.1 Ecosystem at Risk

An ecosystem is composed of biological, physical, and chemical elements that function together in a complex, inter-dependent manner. Ecosystems are dynamic and change with alterations in one or more of their elements. The objective of this section is to describe the ecological setting from which more narrowly defined specific assessment and measurement endpoints (Section 4.2.1.3) can be selected and can be linked together in a CSM. The simplification of complex ecosystem attributes into a select few is necessary for the risk assessment process to be implemented.

Disregarding the influence of environmental contaminants and physical disturbance, the abundance and diversity of wildlife in an area is directly dependent on habitat characteristics such as type, quality and quantity. Primary resources used to describe the habitats that occur in the Henry Site and the species that use these habitats include Site-specific surveys and previous investigations of the Southeast Idaho phosphate resource area region including the *Regional Investigation Report* (MW, 1999) and the regional *Area-wide Human health and Ecological Risk Assessment* (Tetra Tech, 2002). This section is organized into two categories: (1) habitat characteristics and (2) species potentially found at the Henry Site that use these habitats.

Habitat Characteristics. The Henry Site exists in a transitional ecosystem between the Great Basin vegetation to the south and the Rocky Mountain vegetation to the north and east. Land within the area is managed by the state of Idaho, the USFS, and the BLM. There is also private land ownership, and parts of the area are developed and used for agriculture or grazing.

<u>Terrestrial</u> - There are several plant communities present at the Henry Site as a result of variations in elevation, moisture, temperature, soil type, slope and aspect. Plant communities include mixed conifer/aspen forest, sagebrush/grassland, aspen forest, and riparian/wetlands. The mixed aspen and conifer forests are characterized by occasional dense stands of aspen surrounded by open stands of aspens or conifers. Dominant conifer species within the vicinity of the Henry Site include lodgepole pine, Douglas fir, and subalpine fir with understory plants including snowberry, serviceberry, chokecherry, and various grasses and forbs. The sagebrush communities occur mainly on dry soils or rocky outcrops. Dominant species include big sagebrush, mountain snowberry, yellow rabbitbrush, antelope bitterbrush and various forbs such as alfalfa, lupine, scorpion weed, white sage, sticky geranium, and mule's ears, as well as various grass species. Riparian and wetland vegetation is similar in composition to other vegetation communities, with willow, cattail, rush and sedge species often present. Surface water that supports riparian and wetland habitats within the vicinity of the Henry Site have been sampled for periphyton, plankton, macrophytes and benthic invertebrates, and a variety of these species are present.

The habitats described above support a variety of mammalian and avian species. Animals that the conifer-aspen communities support include but are not limited to black bear, snowshoe hare, yellow pine chipmunk, great horned owl, downy woodpecker and western bluebird. Animals that the sagebrush-grass communities support include but are not limited to coyote, deer mouse, prairie falcon, sage grouse and mourning dove. Animals that the riparian and marsh communities support include but are not limited to moose, beaver, muskrat, belted kingfisher, mallard duck, great blue heron, sandhill crane and common snipe (MW, 1999).

A 2009 vegetation survey and sampling event at the Henry Site identified dominant species that were sampled from each area. Most of the areas sampled were sagebrush/grassland communities, as well as some aspen/conifer communities (MWH, 2011). Forested lands, dominated by conifers, occur primarily near the southern end of the Site, with aspen present on the central portion of the ridge bounding the Site to the east. Riparian and wetland areas occur locally near ponds, seeps and springs, and streams, including the Little Blackfoot River.

Vegetation cover on the reclaimed areas of the Site is good to excellent, with better than 90 percent coverage in most areas. Common species at the Henry Site include: *Bromus inermis* (smooth brome); *Bromus marginatus*: (mountain brome); *Dactylis glomerata* (orchardgrass); *Pascopyrum smithii* (western wheatgrass); *Medicago sativa* (alfalfa); *Artemesia ludoviciana* (white sage); *Collomia linearis* (slenderleaf collomia); and *Artemesia tridentate* (big sagebrush).

<u>Aquatic</u> - An aquatic functional use survey of ponds (non-regulated surface water features) at the Sites was conducted in June 2004 (IDEQ, 2004c). This review categorized all ponds into one of three tiers as follows:

- Tier 1 – surface water features that appeared to provide adequate open water, emergent vegetation, protective cover, and food sources to support a local resident migratory bird population during typical nesting/breeding seasons.
- Tier 2 – surface water features within grazing allotments, those exhibiting evidence of livestock use, or ponds with a reasonable potential for future livestock use as drinking water.
- Tier 3 – surface water features used as an occasional drinking water source by transitory terrestrial wildlife.

The results of this survey by Site are summarized in **Table A4-8**. Two of the four ponds at the Henry Site are Tier 1. In addition, relative bed stability (RBS) stream surveys were implemented to characterize the habitat quality of flowing waters at the Henry Site, the results of which are presented in **Table A4-9**. As presented in Section 4.6 of the Henry Site RI Report, attempts were made in 2004 to collect fish in Henry area streams. Of the 20 stations evaluated at the Henry Site, 50% are confirmed to have or are likely to have fish present based on corroborating higher RBS scores. Therefore, exposure to fish by ecological receptors was evaluated for surface water bodies in the Henry Site area.

Species. As previously indicated, prior regional studies have documented species occurrence (MW, 1999; Tetra Tech, 2002). Additionally, many Site-specific studies have been conducted and are sources of information on species that are specifically known to occur on the Henry Site or in relevant background areas (**Table A4-10**). Below, specific invertebrates, reptiles and amphibians, birds, mammals, and threatened and endangered species are presented that have been identified at or near the Henry Site.

<u>Invertebrates -</u> Invertebrates such as worms, insects, crustaceans and spiders, are primary consumers in the food web. Sampling has occurred of both benthic and terrestrial invertebrates. These organisms are

important prey for birds, reptiles, amphibians and small mammal species. Several taxa of invertebrates have been collected at the P4 Sites, including:

Ephemeroptera (mayflies), Odonata (dragonflies and damselflies), Plecoptera (stoneflies), Hemiptera (aphids, cicadas), Coleoptera (beetles), Megaloptera (alderflies, fishflies), Trichoptera (caddis flies), Diptera (mosquitoes), Lepidoptera (moths and butterflies), Erpobdelliformes (leeches), Rhynchobdellida (leeches), Hiridinea (leeches), Haplotaxida (worms), Lumbriculidae (freshwater oligochaetes), Oligochaeta (earthworms), Nematoda (roundworms), Veneroida (bivalve mollusks), Pulmonata (snails and slugs), Mesogastropoda (snails), Gastropoda (mollusks), Ctenobranchiata (mollusks), Amphipoda (crustaceans), Ostracoda (crustaceans), Turbellaria (flatworms), Tricladida (flatworms), and Hydroida (cnidarians).

Reptiles and Amphibians - Reptiles and amphibians have not been surveyed or sampled in the vicinity of the Henry Site, but several species are known to occur, as noted in the Regional Investigation Report (MW, 1999). Amphibians in the area include the tiger salamander, the western toad, the leopard frog and the western chorus frog. Reptiles within the area include the sagebrush lizard, the gopher snake, the western and common garter snake, the racer and the western skink. These organisms are secondary consumers and may be prey for higher trophic level species.

Fish – Fish were confirmed present, or likely to be present based on RBP scores, in several Henry Site streams (**Table A4-9**). Several families of fish are present in regional streams and rivers (**Table A4-11**). These species range from secondary to tertiary consumers that prey on invertebrates and amphibians and may be prey for upper trophic level birds and mammals.

Birds - Birds in the vicinity of the Henry Site exist in all trophic levels (**Table A4-12**). Species like the house finch, the mourning dove and the trumpeter swan are all herbivores. Most species such as the robin, the crow and nuthatch, sparrow and warbler species consume both invertebrates and plant materials. There are also several species that are primarily carnivorous, including the great blue heron, which consume a diet dominantly composed of fish (i.e., piscivorous), and hawks such as the red-tailed hawk, the northern harrier, the Cooper's hawk and several owl species all of which eat mostly small mammals such as mice and voles. Bird eggs from various species have been sampled in the vicinity of the Henry Site.

Mammals - Mammal species within the vicinity of the Henry Site include species at many trophic levels (**Table A4-13**). These species include primary consumers and omnivores such as the deer mouse, the long-tailed vole, the least chipmunk and the Uinta ground squirrel. These species are often prey items for tertiary consumers like the carnivorous coyote. The mink is also a high trophic level species potentially occurring in the vicinity of the Henry Site, which dominantly feeds on area fish. Elk are also present in the vicinity of the Henry Site as primary consumers. Other mammals potentially found in the vicinity of the Henry Site include bats, gophers, beavers, chipmunks, deer, raccoons, porcupines and hares. Mammals that have been sampled on the Henry Site or in the region include: small mammals (deer mouse, least chipmunk, and western harvest mouse), and elk.

Threatened and Endangered Species - Information regarding the potential for listed Endangered Species Act (ESA) species to occur on the Henry Site was obtained from the United States Fish and Wildlife Service (USFWS) and the Canada lynx (*Lynx canadensis*) was reported to be the only threatened or endangered species. To date, no sightings of Canada lynx have been observed by or reported to P4.

4.2.1.2 Stressor Bioavailability and Exposure Routes

Evaluation of toxicity in an ecological receptor requires quantifiable exposure, as well as an understanding of the degree to which the exposure may include a bioavailable fraction that can cause toxicity directly or indirectly through food web transfer. This section describes factors that affect the bioavailability of metals in aquatic and terrestrial environments based on routes of exposure to ecological receptors. Drexler et al. (2003) provides a detailed review of factors affecting metals bioavailability in aquatic and terrestrial systems.

An overriding condition of metals exposure is that metals are naturally occurring and some are essential nutrients, such that plants and animals have evolved intricate strategies to balance nutrient levels and thus modulate exposures to metals (Drexler et al., 2003). These strategies may include: inhibited uptake, detoxification, storage, and increased elimination (Drexler et al., 2003). The ERA did not quantitatively examine the relative contribution of each of these strategies. However, measures of tissue concentrations, for example in upland and riparian plants, provide the best quantitative measure of Site-specific exposure concentrations.

Aquatic Environment. Concentrations of freely dissolved inorganic ions are typically the best indicator of potential for aquatic toxicity to phytoplankton, zooplankton, macroinvertebrates, and fish as evidenced by the development of NRWQC for inorganics (USEPA, 2015b). An exception is selenium, where the primary bioavailable form is particulate (Presser and Luoma, 2010). The bioavailability of selenium depends on site-specific conditions such as water chemistry and hydrology which affect the speciation of selenium as selenate, selenite or organoselenium. The partitioning of selenium in the environment is also unique when compared to other inorganics because selenium uptake is facilitated across biological membranes (Chapman et al., 2009). Water hardness (concentrations of the cations calcium [Ca], magnesium [Mg], manganese [Mn]) can also affect the degree of bioavailability of inorganics and has been specifically incorporated into the application of water quality criteria for cadmium (Cd), chromium III (Cr III), lead (Pb), nickel (Ni), silver (Ag) and zinc (Zn). Per NRWQC guidance, USEPA now requires that the biotic ligand model be used to determine the bioavailability and toxicity for copper. The biotic ligand model is based on the hypothesis that toxicity is not simply related to total aqueous metal concentration, but that both metal-ligand complexation (organic and inorganic) and metal interaction with competing cations at the site of action of toxicity need to be considered. Dissolved organic (DOC) matter is known to be an important ligand for most metals in most natural waters and is an input variable in the biotic ligand model (USEPA, 2007a). Biotic ligand models for other metals (aluminum [Al], Cd, Pb, Ni, Ag, and Zn) are in the development stage, but have not been through review and acceptance by USEPA.

Metal complexation, and therefore, bioavailability and toxicity, is also influenced by pH. Metal ions generally become more available as pH decreases, as the increased hydrogen ions ($H+$) ions compete with metal ions for complexation with DOC.

Terrestrial Environment. As sessile organisms, plants have developed several means of managing toxic levels of metals: 1) exclusion from uptake at the root zone, 2) sequestration in a non-toxic form once accumulated (Grill and Zenk, 1985), and 3) adaptation. Metal tolerant plants are likely to be present in areas with high mineral content, and were historically used in the mining industry to locate potential ore bodies (Baker et al., 1988). Plants may exhibit a wide range of uptake and sensitivity to metals, and bulk soil concentrations have been found to be poor predictors of the bioavailable fraction of metals to plants (Lasat, 2000). Terrestrial invertebrates similarly exhibit a broad range of sensitivities between species and a poor correlation between toxicity and bulk soil concentrations. Terrestrial invertebrates are exposed to contaminants in soil by direct contact and ingestion of soil. Allen (2002) has proposed the development of terrestrial BLMs to determine the bioavailable fraction of metals available to plants, invertebrates, and microbes and thus the potential for toxicity, but terrestrial BLMs have yet to be evaluated by USEPA. Bioavailable forms of metals for uptake include free metal ions and soluble metal complexes. Metal forms that are not bioavailable may be adsorbed to inorganic soil, bound to soil organic matter, precipitated as oxides, hydroxides and carbonates, or embedded in the structure of silicate minerals. Factors known to affect metals bioavailability include: cation exchange capacity (CEC), organic carbon levels, pH, and amorphous Al/Fe (Barnett and Hawkins, 2008).

Birds and mammals may incidentally ingest soil during foraging; soil may also be ingested indirectly through consumption of prey species (e.g., earthworms) with soil in their gut. Soil ingestion as a contaminant exposure route for wildlife is further described in Section 4.2.2.

Sediment. Benthic invertebrates in streams and ponds in the vicinity of the Henry Site are exposed to contaminants in sediment by direct contact and through ingestion. Sediment pore water has been identified as a major route of exposure of infaunal and epibenthic organisms to sediment contaminants (Adams et al., 2001). Factors that influence the bioavailable concentration of metals in pore water include those identified for surface water, as described above.

Sediment ingestion by fish, birds, and mammals may occur incidentally during foraging as well as indirectly through consumption of prey species with sediment in their gut. Sediment ingestion as a contaminant exposure route for wildlife is further described in Section 4.2.2.

Food. Transfer of contaminants to higher level predators is a primary means by which animals are exposed to contaminants and is an integral part of risk assessment modeling practices as developed by USEPA (USEPA, 1993; Drexler et al., 2003) and discussed in Section 4.2.2. Although trophic transfer is an important exposure route for animals, there are very few instances where metals have been found to biomagnify (i.e., increase in concentration with increasing trophic level) (Drexler et al., 2003). Assimilation efficiency of metals from the gut of the predator is dependent on the form of the metal, and how that metal is associated with the prey item. For example, it has been shown for aquatic herbivores that consume algae, it is only the metals that are inside the algal cell that are assimilated, the metals bound to the exterior of the algal cell wall are eliminated through feces (Drexler et al., 2003). Selenium, a particular metal of concern for the Henry Site, can be both rapidly accumulated and rapidly excreted (approximately 70 to 80 percent) such that tissue body burdens may change within days and adverse effects from toxicity in adult birds and mammals may be reversed if the source of selenium exposure is eliminated (USDOI, 1998). In contrast, embryonic deformities due to selenium poisoning are not reversible.

4.2.1.3 Endpoint Receptor Selection

Endpoints define the focus of the ERA and include both assessment and measurement endpoints. Assessment endpoints are explicit statements about what aspects of the ecological system (conditions or processes) are valued and intended for protection. Each assessment endpoint is evaluated for risk, which may not be directly quantifiable. Generally, assessment endpoints are populations or communities of ecological receptors (USEPA, 1997c). Measurement endpoints are the various means by which the assessment endpoints are evaluated. Measurement endpoints are quantifiable indicators of the state of assessment endpoints as determined through laboratory or field experiments.

The assessment and measurement endpoints for this ERA are shown in **Table A4-14**. The assessment endpoints listed in **Table A4-14** are population scale adverse effects to various feeding guilds. The measurement endpoints used to evaluate these assessment endpoints are organismal scale effects which include, but are not limited to, mortality, growth, and reproductive impairment. As described in **Section 4.2.4** below, ecological hazards based on organismal scale measurement endpoints are indicative of individual effects, while the population scale effect is uncertain. In this ERA, it is conservatively assumed that individual adverse effects do not occur in isolation and are potential indicators of adverse effects to the population. Baseline risk evaluations for plants, aquatic invertebrates, terrestrial invertebrates, and reptiles were not selected for detailed risk evaluations as is consistent with prior risk evaluations in the region (Tetra Tech, 2002) and IDEQ's intent to focus resources, minimize future Site-specific risk assessment needs, and make decisions about Site-specific risk management using a process consistent with their regional perspective (IDEQ, 2004b).

It is neither possible nor practical to evaluate the risk posed to every potentially exposed species. Selection of indicator receptors focuses the ecological risk assessment on those ecological features or resources that have substantial aesthetic, social, or economic value or are important in the biological function or biodiversity of the system. Additionally, indicator receptors provide a clear, logical connection between regulatory policy goals and anticipated ecotoxicological investigations. The selected indicator receptors are representative species from the feeding guilds identified for habitats in the Henry Site. A feeding guild represents a group of species which exploit the same ecosystem resources in the same way, and therefore could be expected have the same exposure to environmental contaminants. The criteria used to select the representative indicator receptors were as follows:

- *Species occurrence*. Species known to occur in the vicinity of the Henry Site (e.g., deer mouse) had priority for the evaluation over species that are transient or do not occur in the area (e.g., lynx) because they are likely to have much greater exposure to stressors from the site (discussed in Appendix C of the *RI/FS Work Plan*, Section 4.2.2.1.2 [MWH, 2011]).
- *Exposure frequency*. Receptors that are likely to have the highest exposures were selected over receptors with lower potential exposure. Exposure frequency was evaluated based on the organism's home range. Species with large home ranges (e.g., elk) will have lower exposure frequency to constituents at a site than non-migratory animals with small home ranges (e.g. long-tailed vole) (discussed in detail for selected receptors in Appendix C of the *RI/FS Work Plan* Section 4.2.2 Exposure Analysis [MWH, 2011]).
- *Foraging habits/Feeding guilds*. Foraging habits were evaluated to determine the pathways by which wildlife would become exposed. Both terrestrial and aquatic based foraging habits were evaluated. Species that forage on prey in the sediment will be exposed to contaminants through the incidental ingestion of sediment at higher rates than species that forage in the water column. Additionally, position in the food chain level (i.e., trophic level status) is an indicator of the likelihood of exposure to bioaccumulative constituents, where wildlife in upper trophic levels are more highly exposed. For example, it is expected that a seed eating migratory bird such as the American goldfinch will be less exposed to Site contaminants than a mink that is in greater contact with potentially contaminated media and has a higher trophic position in the food web (**Table A4-12 to Table A4-13**).
- *Ingestion rates*. Intake rates of sediment and food were evaluated because they help determine the potential level of exposure. Within similar feeding guilds, smaller species within a feeding guild will tend to have greater exposure to contaminants because they have higher rates of food consumption relative to their body weight per day, a point which is discussed in detail for selected receptors in Section 4.2.2 Exposure Analysis.

In addition to the factors described above, selection of indicator receptors was based on prior precedence of receptor selection for the region (MW, 1999, Tetra Tech, 2002), and species occurrence described in Appendix C of the *RI/FS Work Plan*, Section 4.2.1.1.2 (MWH, 2011). Wildlife species that were selected as ecological receptors to represent each of the assessment endpoints are presented in **Table A4-14**. Hazards to selected indicator receptors are protective of special status species (i.e., migratory birds and threatened or endangered species) at the organismal scale due to the use of relevant no-adverse-effect-level-based (NOAEL-based) toxicity reference values (TRVs) for attributes such as growth and reproduction.

It should be noted that although elk have a larger summer home range and greater body weight than mule deer, elk was selected as the indicator receptor for the evaluation of large herbivorous mammals. As described in *An Evaluation of the Effects of Selenium on Elk, Mule Deer, and Moose in Southeastern Idaho* (Kuck, 2003a) and *The Management of Big Game Populations, Their Habitat, and Selenium in Southeast Idaho* (Kuck, 2003b), the total population of elk within the Phosphate Resource Area has increased from approximately 230 animals in 1952 to 3,690 animals in 2002, while the population of mule deer have declined from approximately 6,000 animals in 1950 to <3,000 animals in 2002. It is hypothesized that because of decreased summer range quality caused by a succession from aspen to conifer types, and the mule deer's dependence on forbs and other high-quality forage in their diet, the Phosphate Resource Area is no longer able to sustain historic populations of this species (Kuck, 2003b). In contrast, the rapid increase in the elk population in this area probably reflects this specie's broad diet and habitat requirements, and the ability of elk to exploit the changing habitat effectively (Kuck, 2003b). According to Kuck (2003a; 2003b), the population of mule deer within the Phosphate Resource Area is likely to continue to decline, unless fire suppression and other resource management practices are changed. It should also be noted that the elk is a more popular large game animal for hunters within the Phosphate Resource Area than the mule deer. From the standpoint of representativeness, and economic and recreational value, P4 believes that the elk is a more appropriate indicator receptor for large herbivorous mammals than the mule deer. Additionally, mule deer have not been observed at the Henry Site by any Site personnel, while elk have been observed regularly. In regard to home range and exposure potential, although mule deer have a smaller summer home range than the elk, mule deer have a larger total (i.e., summer and winter) home range because they tend to winter in lower elevation areas farther from the waste rock dumps (Kuck, 2003a). As a result, most mule deer do not consume any seleniferous forage in the winter, and they depurate selenium from their bodies by spring (Kuck, 2003b). In contrast, elk do not migrate significantly, and they tend to summer and winter in the same areas (Kuck, 2003a). As a result, elk are believed to have a higher exposure potential than mule deer.

4.2.1.4 Conceptual Site Model

The culmination of problem formulation is the development of a CSM. The CSM for the Henry Site identifies the primary contaminant sources, release mechanisms, transport mechanisms, secondary contaminant sources, potential pathways, and exposure routes for the selected receptors. The migration of potential contaminants from primary sources to secondary sources occurs through various transport processes that were described in detail in Section 3.7 and 3.8 of the *RI/FS Work Plan*. The ecological portion of the conceptual model identifies where contaminant interactions with biota can occur, describes the uptake of site contaminants into the biological system, and diagrams key contaminant exposure pathways. Receptors are exposed to COPECs through direct contact with contaminated media and through food web transfer. **Figure A4-2** depicts the ecological CSM for Henry Site, and includes the sources, transport pathways, the ecological receptors, and the potentially contaminated media to which receptors are most likely exposed. **Figure A4-3** depicts the food web relationships for selected ecological receptors at the Henry Site and illustrates energy and contaminant transfer in the ecosystem which constitutes complete exposure pathways.

4.2.2 Exposure Analysis

In the Tier I assessment, EPCs were based on maximum detected concentrations. In the Tier II assessment, EPCs were derived as the upper bound average concentration. The upper bound average (i.e., the 95%, 97.5%, or 99% UCL on the mean)concentrations were calculated using USEPA's ProUCL software version 5.0.00 (USEPA, 2013). This software calculates the UCL on mean concentrations based on the underlying distribution of the data. If a higher confidence UCL than 95% was recommended by ProUCL, the recommended UCL was utilized. Summary statistics and derived UCL on the mean concentrations for COPCs and COPECs in applicable media at the Henry Site and background locations are further discussed in Section 3.3.2.1, and presented in **Table A3-8** through **Table A3-13**. As described in Section 3.3.2.1, fish consumption by human receptors was only evaluated for surface water locations with fish present or likely to be present. Consumption of fish by ecological receptors was conservatively evaluated using all surface water locations because an ecological receptor might capture and consume prey from streams and springs too small to support game fish. Uncertainty associated modeling fish consumption for all surface water locations is described in Section 6.1.

Exposure analyses were conducted for each of the receptors identified in **Table A4-14.** For these exposure analyses, COPEC concentrations in dietary items were either measured or modeled as described below.

4.2.2.1 Plant Tissue Concentrations

When sufficient (i.e., 5 or more samples) data were available, Site-specific plant tissue concentrations were preferentially used in dose estimate calculations over modeled plant tissue concentrations. Where Site-specific plant tissue data were lacking spatially or not available, plant concentrations were estimated based on soil/sediment-to-plant BAFs selected from the following preferred hierarchy:

1. USEPA EcoSSLs (USEPA, 2007b) available at http://www.epa.gov/ecotox/ecossl/pdf/ecossl_attachment_4-1.pdf
2. Primary literature:
    - *Empirical models for the uptake of inorganic chemicals from soil by plants* (Bechtel Jacobs, 1998b)
    - *A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture* – values for inorganics (Baes et al., 1984)
3. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities (USEPA, 1999)

For COPECs with linear uptake from soil or sediment to terrestrial or aquatic plant tissues, plant tissue concentrations were modeled using **Equation 29**; COPECs with nonlinear uptake from soil or sediment to plant tissues were modeled using regression parameters presented in **Table A4-17**.

(29) $$C_p = C_{sed} \times BAF_{sed-p}$$

Where:

C_p = Total COPEC concentration in plant tissue (mg COPEC/kg dry tissue).

C_S = Concentration of COPEC in soil or sediment (mg COPEC/kg dry soil or sediment)

$BAF_{s/sed-p}$ = Bioaccumulation factor from soil or sediment to plant tissue (kg dry plant tissue/kg dry soil or sediment) as presented in **Table A4-15**.

Aquatic plant concentrations were modeled from sediment for both sediment and surface water COEPCs. When a given COPEC had no sediment data available or was not detected in sediment, surface water data associated with that COPEC was used to estimate an aquatic plant concentration.

4.2.2.2 Terrestrial and Aquatic Invertebrate Tissue Concentrations

Terrestrial and aquatic invertebrate tissue concentrations were estimated based on soil-to-terrestrial invertebrate or sediment-to-aquatic invertebrate BAFs selected from the following preferred hierarchies:

Soil-to-Terrestrial Invertebrate BAF Hierarchy:

1. USEPA EcoSSL (USEPA, 2007b) tools available at http://www.epa.gov/ecotox/ecossl/pdf/ecossl_attachment_4-1.pdf
2. Primary literature:
   - *Development and Validation of Bioaccumulation Models for Earthworms* (Sample et al., 1998a)
   - *Literature-derived bioaccumulation models for earthworms* (Sample et al., 1999)
3. Database sources:
   - Environmental Residue Effects Database (ERED) – maintained by United States Army Corps of Engineers (USACE) and USEPA and available at: http://el.erdc.usace.army.mil/ered/index.cfm (USACE, 2010)
   - USEPA Ecotox Database available at http://cfpub.epa.gov/ecotox/help.cfm?sub=about (USEPA, 2015c)
4. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities (USEPA, 1999)

Sediment-to-Aquatic Invertebrate BAF Hierarchy:

- Biota-sediment Accumulation Factors for Invertebrates (Bechtel Jacobs, 1998b)
- USEPA EcoSSL (USEPA, 2007b) tools available at http://www.epa.gov/ecotox/ecossl/pdf/ecossl_attachment_4-1.pdf
- Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities (USEPA, 1999)

For COPECs with linear uptake from soil or sediment to terrestrial or aquatic invertebrate tissues, invertebrate tissue concentrations were modeled using **Equation 30**; COPECs with nonlinear uptake from soil or sediment to invertebrate tissues were modeled using regression parameters presented in **Table A4-17**.

$$(30) \qquad C_i = C_s \times BAF_{s-i}$$

Where:

C_i = COPEC concentration in invertebrate tissue (mg COPEC/kg dry tissue)
C_S = Concentration of COPEC in soil or sediment (mg COPEC/kg dry soil or sediment)
BAF_{s-i} = Bioaccumulation factor from soil or sediment to invertebrate tissue (kg dry soil or sediment/kg dry invertebrate tissue)

Aquatic invertebrate concentrations were modeled from sediment for both sediment and surface water COEPCs. When a given COPEC had no sediment data available or was not detected in sediment, a surface water BAF and surface water data associated with that COPEC was used to model invertebrate tissue concentrations.

4.2.2.3 Small Mammal Tissue Concentrations

Small mammal tissue concentrations were estimated based on regional-specific soil-to-mammal BAFs from the following preferred hierarchy of sources:

- USEPA EcoSSL tools available at http://www.epa.gov/ecotox/ecossl/pdf/ecossl_attachment_4-1.pdf (USEPA, 2007b)
- Primary literature:
  - Development and Validation of Bioaccumulation Models for Small Mammals (Sample et al., 1998b)

For COPECs with linear uptake from soil to small mammal tissue, small mammal tissue concentrations were modeled using **Equation 31**; COPECs with nonlinear uptake from soil to mammal tissues were modeled using regression parameters presented in **Table A4-17**.

$$(31) \qquad C_m = C_s \times BAF_{(s-m)}$$

Where:

C_m = COPEC concentration in mammalian prey tissue (mg/kg dry tissue)
C_s = COPEC concentration in soil (mg/kg dry soil)
$BAF_{s\text{-}m}$ = Bioaccumulation factor from soil-to-mammal tissue (kg dry soil/kg dry mammal tissue).

4.2.2.4 Fish Tissue Concentrations

Fish tissue concentrations were estimated based on surface water-to-fish BAFs from the following preferred source:

- Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities (USEPA, 1999)

COPEC concentrations in fish tissues were modeled based on the following equation (**Equation 32**):

$$(32) \qquad C_f = C_w \times BAF_{(w-f)}$$

Where:

C_f = COPEC concentration in fish prey tissue (mg/kg dry tissue)
C_s = COPEC concentration in water (mg/L water)
$BAF_{w\text{-}f}$ = Bioaccumulation factor from water-to-fish tissue (L water/kg dry fish tissue).

When a given COPEC had no surface water data available or was not detected in surface water, sediment data associated with that COPEC was used. In this situation, fish tissue concentrations were estimated based on sediment-to-fish BAFs from Bioaccumulation Factor Approach Analysis for metals and Polar Organic Compounds (PTI, 1995).

When a source in any of the above BAF hierarchies did not contain a value or regression for a given COPEC, a default of 1 was used. A summary of all BAFs and regression-based BAF models used in the Tier I and Tier II ERAs are presented in **Table A4-15** and **Table A4-16**, respectively. Equation parameters for non-linear BAF regression equations are presented in **Table A4-17.**

4.2.2.5 Bird and Mammal Dietary Exposure

Dietary exposure modeling based on an oral dose approach (USEPA, 1997c; 1993) was used to estimate exposures for the bird and mammal receptors identified in **Table A4-14**. Wildlife exposure models are used to evaluate the potential for contaminants to move through the food chain and impact organisms occupying higher trophic levels. Characterizing risks to larger vertebrates from specific pollutants often requires the use of exposure modeling because: (1) it is often not feasible to collect sufficient numbers of these organisms to achieve valid sample sizes, (2) it is often not feasible to replicate the highest plausible exposure, (3) the larger home ranges characteristic of predators make it difficult to relate any constituent concentrations found in the bodies of the organisms to the site being evaluated, and (4) behavioral changes such as those influenced by changes in diet and reproductive status, and physiological changes can cause substantial variation in constituent accumulation and exposure making temporally non-replicated measurements inconclusive. Modeled exposures can be related to the effects that have been measured elsewhere for evaluation. This results in an estimate of potential baseline risk that likely overestimates the risk and thus errs on the side of protecting ecological receptors.

The exposure assessment model estimates the dose of the constituent potentially received by indicator receptors. Uptake of contaminants occurs via three primary routes: ingestion, dermal absorption, and inhalation. For wildlife, dermal absorption is of secondary importance due to the protection provided by fur, feathers, and for some species, scaly skin. Furthermore, constituents that are present on the exterior of an organism are often consumed during routine cleaning or, for aquatic organisms, washed away. For non-burrowing mammals and birds, exposure to constituents from inhalation is also deemed to be of secondary importance, since constituents that have the tendency to volatilize will likely be present in outdoor ambient air at low concentrations. Based on this rationale, the risk assessment for vertebrate wildlife at Henry Site was focused on ingestion exposure pathways, which may include the ingestion of food, water, and soil or sediment. The daily exposure of a wildlife receptor (e.g., mammal or bird) to a constituent can be expressed as the sum of the amount of constituent consumed through the ingestion of food, water, and sediment or soil. The dose is typically quantified in milligram of constituent ingested per kilogram body weight of the organism per day (mg/kg-bw/d) as described by the equation below (**Equation 33**).

$$\text{(33)} \qquad \text{Wildlife Dose} = \frac{\left(\sum IR_{biota} \times F_{prey} \times C_{prey} + \sum IR_{abiotic} \times C_{abiotic}\right) \times SUF \times ED}{BW}$$

Where:

Wildlife Dose	= Dose of COPEC ingested (mg/kg-bw/day)
IR_{biota}	= Biota ingestion rate (kg/day)
F_{prey}	= Fraction of each prey item in diet (unitless)
C_{prey}	= Concentration in each prey item (mg/kg)
$IR_{abiotic}$	= Abiotic medium ingestion rate (kg or L/day)
$C_{abiotic}$	= Concentration in abiotic medium (mg/kg or L)

SUF = Site Utilization Factor (unitless)
ED = Exposure duration (unitless)
BW = Body weight of wildlife receptor (kg)

The remainder of this section describes the values selected for each of the exposure parameters noted above; selected exposure parameter values for mammalian and avian receptors are summarized in **Table A4-18**.

Biota Ingestion Rate (IR_{biota}):

Food ingestion rates for wildlife receptors were calculated using allometric equations provided in Nagy (2001). An allometric relationship is the relationship between an organism's body size and metabolic rate relative to some other biological parameter of the organism. The discussion of allometric equations in this ERA for the purpose of deriving receptor-specific ingestion rates is limited to equations that describe the relationship of an organism's body size to its free-living metabolic rate. Because body size is the only variable in an allometric equation, multiple allometric equations have been developed separately for various birds and mammals, although they are not species-specific. Selected food ingestion rate equations for receptors are summarized below:

American Goldfinch (Equation 37 for passerines [Nagy, 2001]):

$$(34) \qquad \mathrm{FIR} = (0.630 \times \mathrm{Wt})^{0.683}$$

Where:

FIR = food ingestion rate (grams [g] dry weight/day)
Wt = average weight of indicator receptor (g)

American Robin and Mallard Duck (Equation 61 for avian omnivore [Nagy, 2001]):

$$(35) \qquad \mathrm{FIR} = (0.670 \times \mathrm{Wt})^{0.627}$$

Where:

FIR = food ingestion rate (g dry weight/day)
Wt = average weight of indicator receptor (g)

Great Blue Heron and Northern Harrier (Equation 63 for avian carnivore [Nagy, 2001]):

$$(36) \qquad \mathrm{FIR} = (0.849 \times \mathrm{Wt})^{0.663}$$

Where:

FIR = food ingestion rate (g dry weight/day)
Wt = average weight of indicator receptor (g)

Elk (Equation 29 for mammalian herbivore [Nagy, 2001]):

$$(37) \qquad \mathrm{FIR} = (0.859 \times \mathrm{Wt})^{0.628}$$

Where:

FIR = food ingestion rate (g dry weight/day)
Wt = average weight of indicator receptor (g)

Raccoon (Equation 33 for mammalian omnivore [Nagy, 2001]):

$$(38) \qquad \text{FIR} = (0.432 \times \text{Wt})^{0.678}$$

Where:

FIR = food ingestion rate (g dry weight/day)
Wt = average weight of indicator receptor (g)

Mink and Coyote (Equation 25 for mammalian carnivore [Nagy, 2001]):

$$(39) \qquad \text{FIR} = (0.153 \times \text{Wt})^{0.834}$$

Where:

FIR = food ingestion rate (g dry weight/day)
Wt = average weight of indicator receptor (g)

Food ingestion rates for the long-tailed vole and deer mouse were based on values given in Table 1 of Nagy (2001).

Fraction of Prey Items in Diet (F_{prey}):

Predator foraging strategies can vary from generalists to specialists. Generalists tend to feed on a variety of prey items and the selection of prey items is predominantly influenced by the abundance and availability of the prey species in the area inhabited. Specialists tend to focus on a specific prey item and have often evolved to exploit specific types of prey. The variable F_{prey} in **Equation 33** represents the percent of the diet each prey item would represent in the receptor's diet given the habitat, ecosystem, and prey availability known to exist at the Henry Site, and the known foraging behavior of the receptor. While it is understood that prey consumption will vary seasonally and that predators consume a variety of prey, the final selected dietary prey items that were used in the risk assessment were determined based on prey items known to occur on the Henry Site, and are intended indicate how various feeding strategies may impact a receptor's exposure to COPECs. The selected fraction of prey items in the diet are summarized in **Table A4-18**.

Concentration in Prey Item (C_{prey}):

Food items for indicator receptors include terrestrial, riparian, and aquatic plants, terrestrial and aquatic invertebrates, fish, and terrestrial vertebrates. Concentrations in prey were determined from available Site-specific data or were estimated using the tools and sources described in Section 4.2.2.2, Section 4.2.2.3, and Section 4.2.2.4.

Abiotic Media Ingestion Rates:

Wildlife ingestion rates for soil and sediment were calculated as a fraction of the receptor's total diet, obtained from Bayer (1994), as presented below:

$$(40) \qquad IR_{soil\ or\ sediment} = IR_{biota} \times f_{soil\ or\ sediment}$$

Where:

$IR_{soil\ or\ sediment}$ = Soil or sediment ingestion rate (kg/day dry weight)
IR_{biota} = Biota ingestion rate (kg/day dry weight)
f_{sed} = Fraction of sediment or soil in diet (%)

The water ingestion rate is used to estimate exposure intake of COPECs through consumption of surface water. Water ingestion rates were calculated based on equations described in the *Wildlife Exposure Factors Handbook* (USEPA, 1993), as follows.

All mammals (Equation 3-17 [USEPA, 1993]):

$$(41) \qquad WI = 0.099 \times Wt^{0.90}$$

Where:

WI = water ingestion rate (L/day)
Wt = average weight of indicator receptor (g)

All birds (Equation 3-15 [USEPA, 1993]):

$$(42) \qquad WI = 0.059 \times Wt^{0.67}$$

Where:

WI = water ingestion rate (L/day)
Wt = average weight of indicator receptor (g)

Site Utilization Factor:

The receptor-specific site utilization factor (SUF) is used to quantify the amount of a site that is utilized by an ecological receptor. If the receptor's home range is smaller than the exposure area, the receptor is assumed to fulfill its forage and shelter requirements on the site and the SUF is equal to one. If, however, the receptor's home range is larger than the exposure area, the home range is assumed to encompass the exposure area and the SUF is equal to the receptor's home range divided by the exposure area.

Wildlife receptor home ranges were obtained from primary literature sources or from the USEPA *Wildlife Exposure Factors Handbook* (USEPA, 1993). The selected home ranges represent the low end of the range of values reported, as appropriate depending upon the range of values and representativeness of the habitat type. The intent of using the low end of literature-derived home range values is to not underestimate exposure. Receptor home ranges are listed in **Table A4-18**. The exposure area for the Henry Site is 1,030 acres.

Exposure Duration:

The exposure duration is the fraction of the year that the wildlife receptor forages on Site. The wildlife species evaluated in the ERA are potential year round residents of southeast Idaho and therefore an exposure duration of one was used for all ecological receptors.

Receptor Body Weight:

Wildlife receptor body weights were obtained from primary literature sources or from the USEPA *Wildlife Exposure Factors Handbook* (USEPA, 1993). The selected body weights represent the mean adult body weight of males and females.

4.2.3 Ecological Effects Analysis

Ecological effects associated with exposure to COPECs in the environment were evaluated by comparing dose estimates to TRVs. Avian and mammalian TRVs are reported in terms of mg/kg-day to correspond to the daily dose exposure units for wildlife. Two TRVs were determined for each avian and mammalian receptor evaluated: (1) the TRV_{NOAEL}, defined as the highest dose at which adverse effects are unlikely to occur; and (2) the TRV_{LOAEL}, defined at the lowest dose where a specific biological effect is expected to occur. Exposure concentrations below the TRV_{LOAEL} are unlikely to result in adverse effects and exposure concentrations below the TRV_{NOAEL} with a high degree of certainty will not result in adverse effects. Only the TRV_{NOAEL} was used in the Tier I screening evaluation, while both the TRV_{LOAEL} and the TRV_{NOAEL} were used to characterize the potential for adverse effects in the Tier II evaluation.

Ecological TRVs for evaluating potential impacts of COPECs on mammalian and avian indicator receptors were obtained from the following hierarchy of sources:

1. USEPA EcoSSLs (USEPA, various dates)
2. ORNL (ORNL, 1996b)
3. Primary literature

Toxicity reference values for mammalian and avian receptors are presented in **Table A4-19** and **Table A4-20**, respectively.

Uncertainty Factors for Mammalian and Avian TRVs:

LOAELs and other toxicity values with endpoints that reflect a level of impact are adjusted to a NOAEL-equivalent value through the application of UFs. In order to arrive at TRV_{NOAEL} values, ORNL (1996b) recommended applying a UF of 2 to adjust acute or subchronic endpoints to chronic endpoints. No UFs were applied to the TRVs that were selected from USEPA's EcoSSLs, as these studies have undergone extensive peer review, use a weight-of-evidence approach and the preponderance of all data, and the TRVs selected are intended to be protective of wildlife under chronic exposures.

A determination regarding whether or not a mammalian toxicity study represented subchronic or chronic exposures was based either on the duration of the experiment relative to the lifespan of the test species, or whether the exposure occurred during a critical lifestage (e.g., mating, gestation, lactation). A mammalian toxicity study was determined to be chronic if exposure was at least 50 percent of a species' lifespan, based on technical support information presented in the Great Lakes Water Quality Initiative Wildlife Criteria (USEPA, 1995a; 1995b) and ORNL (1996b). Reproductive and development periods (e.g., mating, gestation, or lactation) are particularly sensitive life stages due to the stressed condition of the adults and the rapid growth and differentiation occurring within the embryo (ORNL, 1996b). Because benchmarks are intended to evaluate the potential for adverse effects on wildlife populations, consistent with assessment endpoints in this ERA and ORNL (1996b), exposures that occurred during a species' reproductive or development period (i.e., critical life stage) were considered to represent chronic exposures.

There is limited information available concerning the life spans of birds used in toxicity tests. Therefore, consistent with ORNL (1996b), avian studies with exposure durations greater than 10 weeks were considered to represent chronic studies.

4.2.4 Risk Characterization

Risk characterization is the final phase of risk assessment in which the likelihood of adverse effects is evaluated by combining results of the exposure analysis and effects analysis. Risk characterization consists of estimating and describing risk, including the assumptions and level of uncertainty associated with the risk estimate. The assessment endpoints evaluated and each evaluation method is a line of evidence. In this ERA, the analyses and risk characterization phases are reported for each assessment endpoint.

It should be noted that due to the lack of relevant toxicity data in peer-reviewed literature, fish, amphibians, and reptiles were semi-quantitatively evaluated in the ERA. The risk characterization for fish and amphibians compared measured COPEC concentrations in surface water to the appropriate water quality criteria to calculate a HQ as described by **Equation 43**. This approach is expected to be protective of the early-life stage of fish and amphibian embryos and tadpoles, and ultimately adult amphibian consumers.

$$(43) \qquad \mathrm{HQ} = \frac{\mathrm{C_{sw}}}{\mathrm{AWQC}}$$

Where:

HQ = Hazard quotient
C_{sw} = Measured surface water concentration (mg/L)
AWQC = Ambient water quality criteria (mg/L)

The risk characterization for wildlife is a process of integrating the modeled dietary receptor exposures and constituent toxicity information discussed in the analysis section. Wildlife exposure and toxicity data were integrated using **Equation 44** to calculate an HQ.

$$(44) \qquad \mathrm{HQ} = \frac{\mathrm{Dose}}{\mathrm{TRV}}$$

Where:

HQ = Hazard quotient
Dose = Total ingested daily dose of a constituent (mg/kg-d)
TRV = Toxicity reference value (mg/kg-d)

The ecological HQ estimate calculations presented in Appendices F through I were performed using the full unrounded value of medium-specific dose estimates, although the values presented in Appendices F through I were rounded for display purposes. Media concentrations less than 100 were rounded to three significant figures and HQ estimates less than 10 were rounded to two significant digits. Media concentrations greater than 100, HQ estimates greater than 10 were rounded to the nearest whole number.

For ecological receptors, the HQ is generally interpreted as follows:

- An HQ_{NOAEL} < 1.0 indicates that toxicological effects and potential risk are likely not occurring.

- An HQ_{NOAEL} > 1.0 and an HQ_{LOAEL} < 1.0 generally indicates that toxicological effects and potential risk may occur to individual receptors. Whether or not risks occur is dependent on the confidence in the toxicity values used and the LOAEL's magnitude relative to the NOAEL.
- An HQ_{LOAEL} >1.0 indicates that toxicological effects and potential risk may occur to populations of ecological receptors.

The most that can be concluded from a calculated HQ in excess of one is that there is an increased potential that an adverse effect may occur in at least one individual. While this potential increases as the magnitude of the HQ increases, the level of concern does not increase linearly with increases in HQ. This lack of linearity is based on the fact that typical dose response curves for constituents are not linear, but rather sigmoidal.

A discussion of uncertainty is an important component of risk characterization since they have the potential to bias (high or low) risk estimates. Sources of uncertainty associated with wildlife exposure include:

- Site use
- Exposure concentration
- Receptors selected as surrogate species for all mammalian and avian species that are potentially exposed at the site
- Assumptions regarding dietary preferences
- Constituent bioavailability
- Constituent toxicity

4.3 Summary of Ecological Hazard Estimates

Potential hazards for ecological receptors exposed to COPECs in environmental media at the Henry Site and background locations are summarized in this section.
Tier I and Tier II cumulative ecological hazard estimates for upper trophic level receptors exposed to COPECs in environmental media at the Henry Site and background locations are presented in Sections 4.3.1 and 4.3.2, respectively. Detailed Tier I and Tier II ecological hazard estimates for the Henry Site and background locations are presented in **Attachment F** through **Attachment I**.

As shown in **Figure A4-2**, ecological indicator receptors were evaluated for the following direct and indirect exposure pathways:

- long tailed vole exposed to upland surface soil, surface water, and vegetation;
- elk exposed to upland surface soil, surface water, and vegetation;
- American goldfinch exposed to upland surface soil, surface water, and vegetation;
- deer mouse exposed upland surface soil, surface water, vegetation, and terrestrial invertebrates;
- raccoon exposed to riparian surface soil, surface water, sediment, vegetation, terrestrial invertebrates, small terrestrial vertebrates, aquatic invertebrates, and fish;
- American robin exposed to upland surface soil, surface water, vegetation, and invertebrates;
- mallard exposed to surface water, sediment, vegetation, aquatic plants, and invertebrates;
- mink exposed to riparian surface soil, surface water, sediment, small terrestrial vertebrates, aquatic invertebrates, and fish;
- coyote exposed to upland surface soil, surface water, vegetation, small terrestrial vertebrates, and terrestrial invertebrates;

- great blue heron exposed to riparian surface soil, surface water, sediment, small terrestrial vertebrates, aquatic invertebrates, and fish; and
- northern harrier exposed to upland surface soil, surface water, and small terrestrial vertebrates.

4.3.1 Tier I Ecological Hazard Estimates

Tier I ecological hazard estimates for applicable receptors exposed to environmental media at the Henry Site and background locations are described below and summarized in **Table A4-21** through **Table A4-23**.

Amphibians and Fish

Constituent-specific HQs for amphibians and fish exposed to dissolved surface water COPECs at the Henry Site ranged from 0.61 to 313, as shown in **Table A4-21**. Surface water COPECs with HQs higher than IDEQ's and USEPA's acceptable hazard criterion of 1 are aluminum, barium, boron, cadmium, manganese, nickel, selenium, uranium, vanadium, and zinc. Due to the lack of dose modeling and oral toxicity data for amphibians and fish, no dose modeling was performed for either receptor. Instead, hazards were based on a comparison of the maximum detected concentration from all Henry Site surface water samples to surface water effects criteria to account for potential effects to both fish and early life stage amphibians. This conservative ecological evaluation is intended to identify constituents for further evaluation in water-body specific assessments, and does not imply that excess hazard associated with the constituents listed above is applicable to at every sample location.

Fish tissue concentration data for streams at or near the Henry Site are available for select metals, and were evaluated in conjunction with surface water effects criteria as part of the ecological assessment for fish. These fish tissue concentrations are summarized below, along with fish tissue benchmarks associated with no adverse effects concentrations in published aquatic toxicity tests. Tissue concentrations in fish collected from all Henry Site and background sampling stations are less than published fish tissue benchmarks for selenium and vanadium. Tissue concentrations in fish collected from one Henry Site sampling station each are higher than published fish tissue benchmarks for cadmium, nickel and zinc. The tissue concentration for nickel in fish collected from one background sampling station is higher than the published fish tissue benchmark.

	Cadmium [a]	Nickel [a]	Selenium [a]	Vanadium [a]	Zinc [a]
Fish Tissue Benchmark [b]	0.65	4.10	8.5	2.9	207
Henry Site Location ID (Description)					
MRV016 (Reservoir Delta at Little Blackfoot River)	0.102	2.60	2.80	0.493	160
MST043 (Little Blackfoot River, below Long Valley Creek)	0.893	3.73	6.10	0.413	183
MST053 (Lone Pine Creek, above Little Blackfoot River)	0.150	8.20	3.50	0.615	230
MST234 (Little Blackfoot River, above Blackfoot Reservoir)	< 0.0787	3.33	3.90	0.427	197
Henry Site Concentration (average)	0.306	4.47	4.08	0.487	193
Background Location ID (Description)					
MST048 (Little Blackfoot River, below Reese Creek)	0.150	2.70	3.70	0.700	170
MST254 (Little Blackfoot R., upstream of Henry cutoff road)	< 0.240	24.0	< 2.40	0.950	180
Background Concentration (average)	0.195	13.4	3.05	0.825	175

Notes:

[a] Fish tissue benchmarks and measured whole body forage fish concentrations are in units of milligrams of metal per kilogram fish tissue, dry weight. Tissue benchmarks originally presented in wet weight were converted to dry weight using a factor of 5 from USEPA (1999).

[b] Fish tissue benchmarks are concentrations associated with no adverse effects in toxicity tests. Fish tissue benchmarks were derived from the following sources: Benoit et al 1976 (cadmium), Jarvinen and Ankley 1999 (vanadium) and Pierson 1981 (zinc) as cited in CH2M Hill (2015); the lowest concentration in muscle tissue of trout exposed for 180 days (no whole body available) in Jarvinen and Ankley 1999 (nickel); and USEPA, 2016c (selenium).

Long-tailed Vole

The NOAEL-based Tier I HQ estimates for a long-tailed vole exposed to contaminated media at the Henry Site range from 0.00022 to 333, as shown in **Table A4-22**. Constituents with Tier I hazard estimates exceeding an HQ of 1 for the long-tailed vole are antimony, arsenic, cadmium, chromium, copper, molybdenum, nickel, selenium, thallium, vanadium, and zinc.

The NOAEL-based Tier I HQ estimates for a long-tailed vole exposed to media at background sampling locations range from 0.00013 to 29, as shown in **Table A4-23**. Constituents with Tier I hazard estimates exceeding an HQ of 1 for the long-tailed vole are antimony, cadmium, chromium, molybdenum, nickel, selenium, thallium and zinc.

Elk

The NOAEL-based Tier I HQ estimates for elk exposed to contaminated media at the Henry Site range from 0.0000054 to 0.55, as shown in **Table A4-22**. These HQ estimates are all less than the ecological hazard criterion of 1; therefore, the elk was eliminated from further consideration in the Tier II ERA.

The NOAEL-based Tier I HQ estimates for elk exposed to media at background sampling locations range from 0.0000033 to 0.046, as shown in **Table A4-23**. These HQ estimates are all less than the ecological hazard criterion of 1.

American Goldfinch

The NOAEL-based Tier I HQ estimates for an American goldfinch exposed to contaminated media at the Henry Site range from 0.00043 to 164, as shown in **Table A4-22**. Constituents with Tier I hazard estimates exceeding an HQ of 1 for the American goldfinch are arsenic, cadmium, chromium, copper, molybdenum, nickel, selenium, vanadium and zinc.

The NOAEL-based Tier I HQ estimates for an American goldfinch exposed to media at background sampling locations range from 0.000063 to 31, as shown in **Table A4-23**. Constituents with Tier I hazard estimates exceeding an HQ of 1 for the American goldfinch are cadmium, chromium, copper, nickel, selenium, vanadium, and zinc.

Deer Mouse

The NOAEL-based Tier I HQ estimates for a deer mouse exposed to contaminated media at the Henry Site range from 0.00023 to 166, as shown in **Table A4-22**. Constituents with Tier I hazard estimates exceeding an HQ of 1 for the deer mouse are antimony, arsenic, cadmium, chromium, copper, molybdenum, nickel, selenium, thallium, uranium, vanadium, and zinc.

The NOAEL-based Tier I HQ estimates for a deer mouse exposed to media at background sampling locations range from 0.00014 to 29, as shown in **Table A4-23**. Constituents with Tier I hazard estimates exceeding an HQ of 1 for the deer mouse are antimony, cadmium, chromium, molybdenum, nickel, selenium, thallium, uranium and zinc.

Raccoon

The NOAEL-based Tier I HQ estimates for a raccoon exposed to contaminated media at the Henry Site range from 0.00022 to 9.6, as shown in **Table A4-22**. Constituents with Tier I hazard estimates exceeding an HQ of 1 for the raccoon are aluminum, selenium and thallium.

The NOAEL-based Tier I HQ estimates for a raccoon exposed to media at background sampling locations range from 0.000074 to 4.4, as shown in **Table A4-23**. The only Constituent with a Tier I hazard estimate exceeding an HQ of 1 for the raccoon is aluminum.

American Robin

The NOAEL-based Tier I HQ estimates for an American robin exposed to contaminated media at the Henry Site range from 0.00025 to 60, as shown in **Table A4-22**. Constituents with Tier I hazard estimates exceeding an HQ of 1 for the American robin are cadmium, chromium, copper, molybdenum, nickel, selenium, vanadium, and zinc.

The NOAEL-based Tier I HQ estimates for an American robin exposed to media at background sampling locations range from 0.000036 to 18, as shown in **Table A4-23**. Constituents with Tier I hazard estimates exceeding an HQ of 1 for the American robin are cadmium, chromium, copper, nickel, selenium, vanadium and zinc.

Mallard

The NOAEL-based Tier I HQ estimates for a mallard duck exposed to contaminated media at the Henry Site range from 0.0061 to 16, as shown in **Table A4-22**. Constituents with Tier I hazard estimates exceeding an HQ of 1 for the mallard are aluminum, selenium, and vanadium.

The NOAEL-based Tier I HQ estimates for a mallard duck exposed to media at background sampling locations range from 0.0053 to 3.2, as shown in **Table A4-23**. The only constituents with a Tier I hazard estimate exceeding an HQ of 1 for the mallard is aluminum.

Mink

The NOAEL-based Tier I HQ estimates for a mink exposed to contaminated media at the Henry Site range from 0.0055 to 722, as shown in **Table A4-22**. Constituents with Tier I hazard estimates exceeding an HQ of 1 for the mink are aluminum, antimony, arsenic, cadmium, chromium, copper, molybdenum, nickel, selenium, thallium, vanadium, and zinc.

The NOAEL-based Tier I HQ estimates for a mink exposed to media at background sampling locations range from 0.0083 to 314, as shown in **Table A4-23**. Constituents with Tier I hazard estimates exceeding an HQ of 1 for the mink are aluminum, antimony, chromium, copper, nickel, selenium, and thallium.

Coyote

The NOAEL-based Tier I HQ estimates for a coyote exposed to contaminated media at the Henry Site range from 0.000017 to 6.6, as shown in **Table A4-22**. Constituents with Tier I hazard estimates exceeding an HQ of 1 for the coyote are molybdenum, selenium, thallium and uranium

The NOAEL-based Tier I HQ estimates for a coyote exposed to media at background sampling locations range from 0.000010 to 5.1, as shown in **Table A4-23**. Constituents with Tier I hazard estimates exceeding an HQ of 1 for the coyote are molybdenum, selenium and thallium.

Great Blue Heron

The NOAEL-based Tier I HQ estimates for a great blue heron exposed to contaminated media at the Henry Site range from 0.00017 to 101, as shown in **Table A4-22**. Constituents with Tier I hazard estimates exceeding an HQ of 1 for the great blue heron are cadmium, nickel, selenium, thallium, vanadium and zinc.

The NOAEL-based Tier I HQ estimates for a great blue heron exposed to media at background sampling locations range from 0.0010 to 1.0, as shown in **Table A4-23**. These HQ estimates do not exceed the ecological hazard criterion of 1.

Northern Harrier

The NOAEL-based Tier I HQ estimates for a northern harrier exposed to contaminated media at the Henry Site range from 0.00014 to 3.7, as shown in **Table A4-22**. Constituents with Tier I hazard estimates exceeding an HQ of 1 for the northern harrier are chromium, molybdenum, selenium and vanadium.

The NOAEL-based Tier I HQ estimates for a northern harrier exposed to media at background sampling locations range from 0.000021 to 2.3, as shown in **Table A4-23**. The only constituent with a Tier I hazard estimate exceeding an HQ of 1 for the northern harrier is vanadium.

4.3.2 Tier II Ecological Hazard Estimates

Tier II ecological hazard estimates for applicable receptors exposed to environmental media at the Henry Site and background are described below and summarized in **Table A4-24** and **Table A4-25**.

Long-tailed Vole

The NOAEL-based Tier II HQ estimates for a long-tailed vole exposed to contaminated media at the Henry Site range from 0.012 to 38, as shown in **Table A4-24**. Constituents with Tier II hazard estimates exceeding an HQ of 1 for the long-tailed vole are antimony, chromium, molybdenum, nickel, selenium and thallium.

The NOAEL-based Tier II HQ estimates for a long-tailed vole exposed to media at background sampling locations range from 0.0071 to 28, as shown in **Table A4-25**. Constituents with Tier II hazard estimates exceeding an HQ of 1 for the long-tailed vole are antimony, molybdenum, selenium and thallium.

The LOAEL-based Tier II HQ estimates for a long-tailed vole exposed to contaminated media at the Henry Site range from 0.0012 to 37, as shown in **Table A4-24**. Constituents with Tier II hazard estimates exceeding an HQ of 1 for the long-tailed vole are chromium, molybdenum, nickel, selenium and thallium.

The LOAEL-based Tier II HQ estimates for a long-tailed vole exposed to media at background sampling locations range from 0.00071 to 2.8, as shown in **Table A4-25**. Constituents with Tier II hazard estimates exceeding an HQ of 1 for the long-tailed vole are antimony and selenium.

American Goldfinch

The NOAEL-based Tier II HQ estimates for an American goldfinch exposed to contaminated media at the Henry Site range from 0.00035 to 19, as shown in **Table A4-24**. Constituents with Tier II hazard estimates exceeding an HQ of 1 for the American goldfinch are chromium, copper, molybdenum, nickel, selenium and vanadium.

The NOAEL-based Tier II HQ estimates for an American goldfinch exposed to media at background sampling locations range from 0.00021 to 7.8, as shown in **Table A4-25**. Constituents with Tier II hazard estimates exceeding an HQ of 1 for the American goldfinch are chromium, selenium and vanadium.

The LOAEL-based Tier II HQ estimates for an American goldfinch exposed to contaminated media at the Henry Site range from 0.029 to 15, as shown in **Table A4-24**. Constituents with Tier II hazard estimates exceeding an HQ of 1 for the American goldfinch are chromium, copper, selenium and vanadium.

The LOAEL-based Tier II HQ estimates for an American goldfinch exposed to media at background sampling locations range from 0.0049 to 6.5, as shown in **Table A4-25**. Constituents with Tier II hazard estimates exceeding an HQ of 1 for the American goldfinch are chromium and vanadium.

Deer Mouse

The NOAEL-based Tier II HQ estimates for a deer mouse exposed to contaminated media at the Henry Site range from 0.013 to 36, as shown in **Table A4-24**. Constituents with Tier II hazard estimates exceeding an HQ of 1 for the deer mouse are antimony, cadmium, chromium, copper, molybdenum, nickel, selenium, and thallium.

The NOAEL-based Tier II HQ estimates for a deer mouse exposed to media at background sampling locations range from 0.0075 to 12, as shown in **Table A4-25**. Constituents with Tier II hazard estimates exceeding an HQ of 1 for the deer mouse are antimony, cadmium, chromium, molybdenum, nickel, selenium and thallium.

The LOAEL-based Tier II HQ estimates for a deer mouse exposed to contaminated media at the Henry Site range from 0.0013 to 23, as shown in **Table A4-24**. Constituents with Tier II hazard estimates exceeding an HQ of 1 for the deer mouse are cadmium, chromium, molybdenum, nickel, selenium, and thallium.

The LOAEL-based Tier II HQ estimates for a deer mouse exposed to media at background sampling locations range from 0.00075 to 5.6, as shown in **Table A4-25**. Constituents with Tier II hazard estimates exceeding an HQ of 1 for the deer mouse are antimony, cadmium, chromium, nickel, selenium and thallium.

Raccoon

The NOAEL-based Tier II HQ estimates for a raccoon exposed to contaminated media at the Henry Site range from 0.0025 to 1.8, as shown in **Table A4-24**. The only constituent with a Tier II hazard estimates exceeding an HQ of 1 for the raccoon is aluminum.

The NOAEL-based Tier II HQ estimates for a raccoon exposed to media at background sampling locations range from 0.0013 to 1.1, as shown in **Table A4-25**. The only constituent with a Tier II hazard estimate exceeding an HQ of 1 for the raccoon is aluminum.

The LOAEL-based Tier II HQ estimates for a raccoon exposed to contaminated media at the Henry Site range from 0.0016 to 0.87, as shown in **Table A4-24**. These HQ estimates are all less than the ecological hazard criterion of 1.

The LOAEL-based Tier II HQ estimates for a raccoon exposed to media at background sampling locations range from 0.00084 to 0.11, as shown in **Table A4-25**. These HQ estimates are all less than the ecological hazard criterion of 1.

American Robin

The NOAEL-based Tier II HQ estimates for an American robin exposed to contaminated media at the Henry Site range from 0.00020 to 10, as shown in **Table A4-24**. Constituents with Tier II hazard estimates exceeding an HQ of 1 for the American robin are cadmium, chromium, copper, nickel, selenium, vanadium and zinc.

The NOAEL-based Tier II HQ estimates for an American robin exposed to media at background sampling locations range from 0.00012 to 4.5, as shown in **Table A4-25**. Constituents with Tier II hazard estimates exceeding an HQ of 1 for the American robin are cadmium, chromium, selenium and vanadium.

The LOAEL-based Tier II HQ estimates for an American robin exposed to contaminated media at the Henry Site range from 0.036 to 8.6, as shown in **Table A4-24**. Constituents with Tier II hazard estimates exceeding an HQ of 1 for the American robin are cadmium, chromium, copper, nickel, selenium, vanadium and zinc.

The LOAEL-based Tier II HQ estimates for an American robin exposed to media at background sampling locations range from 0.013 to 3.8, as shown in **Table A4-25**. Constituents with Tier II hazard estimates exceeding an HQ of 1 for the American robin are cadmium, chromium, selenium and vanadium.

Mallard

The NOAEL-based Tier II HQ estimates for a mallard exposed to contaminated media at the Henry Site range from 0.042 to 6.1, as shown in **Table A4-24**. Constituents with Tier II hazard estimates exceeding an HQ of 1 for the mallard are aluminum, selenium and vanadium.

The NOAEL-based Tier II HQ estimates for a mallard exposed to media at background sampling locations range from 0.0053 to 0.78, as shown in **Table A4-25**. These HQ estimates are all less than the ecological hazard criterion of 1.

The LOAEL-based Tier II HQ estimates for a mallard exposed to contaminated media at the Henry Site range from 0.0047 to 4.8, as shown in **Table A4-24**. Constituents with Tier II hazard estimates exceeding an HQ of 1 for the mallard are selenium and vanadium.

The LOAEL-based Tier II HQ estimates for a mallard exposed to media at background sampling locations range from 0.0039 to 0.25, as shown in **Table A4-25**. These HQ estimates are all less than the ecological hazard criterion of 1.

Mink

The NOAEL-based Tier II HQ estimates for a mink exposed to contaminated media at the Henry Site range from 0.45 to 176, as shown in **Table A4-24**. Constituents with Tier II hazard estimates exceeding an

HQ of 1 for the mink are aluminum, antimony, cadmium, chromium, copper, molybdenum, nickel, selenium, thallium, vanadium and zinc.

The NOAEL-based Tier II HQ estimates for a mink exposed to media at background sampling locations range from 0.10 to 312, as shown in **Table A4-25**. Constituents with Tier II hazard estimates exceeding an HQ of 1 for the mink are aluminum, antimony, copper, nickel, selenium and thallium.

The LOAEL-based Tier II HQ estimates for a mink exposed to contaminated media at the Henry Site range from 0.22 to 79, as shown in **Table A4-24**. Constituents with Tier II hazard estimates exceeding an HQ of 1 for the mink are aluminum, cadmium, chromium, nickel, selenium, thallium, vanadium and zinc.

The LOAEL-based Tier II HQ estimates for a mink exposed to media at background sampling locations range from 0.065 to 31, as shown in **Table A4-25**. Constituents with Tier II hazard estimates exceeding an HQ of 1 for the mink are aluminum, antimony, copper, selenium and thallium.

Coyote

The NOAEL-based Tier II HQ estimates for a coyote exposed to contaminated media at the Henry Site range from 0.00093 to 3.0, as shown in **Table A4-24**. Constituents with Tier II hazard estimates exceeding an HQ of 1 for the coyote are molybdenum, selenium and thallium.

The NOAEL-based Tier II HQ estimates for a coyote exposed to media at background sampling locations range from 0.00056 to 1.4, as shown in **Table A4-25**. The only constituent with a Tier II hazard estimate exceeding an HQ of 1 for the coyote is molybdenum.

The LOAEL-based Tier II HQ estimates for a coyote exposed to contaminated media at the Henry Site range from 0.000093 to 1.4, as shown in **Table A4-24**. The only constituent with a Tier II hazard estimate exceeding an HQ of 1 for the coyote is selenium.

The LOAEL-based Tier II HQ estimates for a coyote exposed to media at background sampling locations range from 0.000056 to 0.48, as shown in **Table A4-25**. These HQ estimates are all less than the ecological hazard criterion of 1.

Great Blue Heron

The NOAEL-based Tier II HQ estimates for a great blue heron exposed to contaminated media at the Henry Site range from 0.0010 to 11, as shown in **Table A4-24**. Constituents with Tier II hazard estimates exceeding an HQ of 1 for the great blue heron are selenium and zinc.

The NOAEL-based Tier II HQ estimates for a great blue heron exposed to media at background sampling locations range from 0.00061 to 1.0, as shown in **Table A4-25**. These HQ estimates do not exceed the ecological hazard criterion of 1.

The LOAEL-based Tier II HQ estimates for a great blue heron exposed to contaminated media at the Henry Site range from 0.0021 to 8.6, as shown in **Table A4-24**. Constituents with Tier II hazard estimates exceeding an HQ of 1 for the great blue heron are selenium and zinc.

The LOAEL-based Tier II HQ estimates for a great blue heron exposed to media at background sampling locations range from 0.00022 to 0.29, as shown in **Table A4-25**. These HQ estimates are all less than the ecological hazard criterion of 1.

Northern Harrier

The NOAEL-based Tier II HQ estimates for a northern harrier exposed to contaminated media at the Henry Site range from 0.00012 to 1.3, as shown in **Table A4-24**. Constituents with Tier II hazard estimates exceeding an HQ of 1 for the northern harrier are selenium and vanadium.

The NOAEL-based Tier II HQ estimates for a northern harrier exposed to media at background sampling locations range from 0.000069 to 0.59, as shown in **Table A4-25**. These HQ estimates are all less than the ecological hazard criterion of 1.

The LOAEL-based Tier II HQ estimates for a northern harrier exposed to contaminated media at the Henry Site range from 0.0056 to 1.1, as shown in **Table A4-24**. The only constituent with a Tier II hazard estimate exceeding an HQ of 1 for the northern harrier is vanadium.

The LOAEL-based Tier II HQ estimates for a northern harrier exposed to media at background sampling locations range from 0.0022 to 0.49, as shown in **Table A4-25**. These HQ estimates are all less than the ecological hazard criterion of 1

4.3.3 Tier II Henry Site Hazard Estimates vs Tier II Background Hazard Estimates

No incremental hazard estimates were calculated for ecological receptors, however, for some COPECs and receptors the hazard associated with exposure to media at background locations exceeded the hazard associated with media at Henry Site locations. These COPECs and receptors are described below.

Antimony in Upland Soil

As shown in **Tables A4-24** and **A4-25**, NOAEL-based and LOAEL-based hazard estimates for the deer mouse and long-tailed vole exposed to antimony in upland soil are higher at background locations than at the Site. No other ecological receptors had excess hazard estimates associated with antimony in upland soil, and therefore antimony was not considered to be a risk driver for upland soil.

Antimony and Thallium in Riparian Soil and Sediment

As shown in **Tables A4-24** and **A4-25**, hazard estimates for a mink exposed to antimony and thallium riparian soil and sediment were greater for background locations than at the Henry Site. Antimony and thallium were not risk drivers for any other receptor exposed to riparian soil and sediment; therefore, these metals are not considered to be risk drivers for these media.

5.0 LIVESTOCK RISK ASSESSMENT

Public and private lands within and around the Site have historically been used for livestock grazing. Cattle and sheep are the primary livestock that are grazed within the vicinity of the Site; however, horses have also been grazed within the vicinity of the Site. Historical incidents of livestock mortalities have occurred in the region, including at the P4 Sites, as documented in Appendix E of the Conda RI/FS Work Plan (NewFields, 2008) and Davis et al. (2012). As recently as August 2015, an incident of cattle mortality occurred near the Ballard Site as a result of suspected unauthorized grazing on the Site, as evidenced by dung, grazed vegetation, and damage to the fence separating the Ballard Site from State-Leased grazing land. Potential hazards of selenium and other COPCs on livestock was a significant factor leading to the Regional Investigation (MW, 1999), as well as the site-specific RIs.

This livestock risk assessment (LRA) describes the methods used in, and results of, an evaluation of the potential hazards that selenium and other Site contaminants pose to livestock. As described in more detail below, this LRA was structured in a tiered manner with each tier presenting further refinements to the exposure and effects characterization steps used in the preceding tier. Following the identification of LCOPCs, a Tier I LRA was performed that consisted of a conservative, screening-level risk evaluation to refine livestock LCOPCs and media of concern for further evaluation in the Tier II LRA. The Tier II LRA consists of a Site-specific, baseline LRA that used refined exposure assessment and effects characterization methods. Results of the Tier II LRA will be used to identify the potential hazards that current concentrations of selenium and other Site contaminants pose to livestock, and to assist in the refinement of best management practices (BMPs) for future livestock grazing at the P4 Sites.

5.1 Identification of LCOPCs

As described in the livestock CSM (Section 5.2.1.5), the environmental media with complete and potentially significant exposure pathways for livestock are: upland soil, upland vegetation, and surface water in the stock ponds. Screening levels for soil for the protection of livestock are not readily available for the majority of constituents detected in upland soil at the Henry Site. Therefore, all soil COPECs for mammals identified in the ERA for the Henry Site were assumed to also be LCOPCs. Although screening levels for vegetation that are protective of livestock are available for selenium and some other LCOPCs detected in upland soil at the Henry Site, upland vegetation data were not screened, and all LCOPCs evaluated for upland soil exposure were also be assumed to be LCOPCs for upland vegetation.

Screening levels for drinking water that are protective of livestock are also available for selenium and some other constituents detected in surface water at the Henry Site. However, because water criteria are not available for all metals detected at the Henry Site, and for consistency with the identification of LCOPCs in soil, all COPECs identified for surface water at the Site were assumed to also be LCOPCs for surface water. This assumption is conservative because surface water COPEC screening criteria are based on the protection of organisms that inhabit fresh surface water bodies and, therefore, are generally lower than drinking water criteria protective of livestock. For example, the surface water COPEC screening criterion for selenium of 0.005 mg/L (**Table A4-3**) is 100-fold lower than the upper range of concentrations (0.50 – 0.10 mg/L) considered to be safe for livestock consumption (NRC, 1980). Surface water COPEC screening criteria presented in **Table A4-3** through **Table A4-5** are lower than drinking water screening benchmarks for livestock cited in Table 4-4 of the Conda/Woodall Mountain Mine RI/FS Site-Specific Livestock Risk Assessment Report (Formation Environmental, 2016) for all constituents except manganese and molybdenum. Although the ecological screening value for manganese is higher than the drinking water benchmark for livestock, the maximum detected concentration of manganese exceeded both ecological and livestock benchmarks, and manganese was quantitatively evaluated in both the ERA and LRA. The maximum detected concentration of molybdenum in surface water (0.04 mg/L) does not exceed the screening benchmark for ecological receptors (0.37 mg/L) or livestock (0.3 mg/L), and therefore molybdenum was not evaluated in the ERA or LRA.

Ecological screening levels for upland soil and surface water are presented in **Table A4-1** and **Table A4-3** through **Table A4-5**. A summary of LCOPCs for these media is presented in **Table A5-1**.

5.2 Tier I and II LRA

Currently, there is no State or federal guidance for conducting predictive risk assessment in livestock. Therefore, ERA procedures described by USEPA under CERCLA (USEPA, 1997d) were used to quantitatively evaluate potential risks to livestock. Similar to the ERA that was performed for the Site, risk estimates from the Tier I LRA are termed screening-level risk estimates and those from the Tier II LRA are termed baseline risk estimates. The tiered process is intended to focus and refine the risk evaluation by potentially eliminating either LCOPCs from the baseline LRA that are insignificant, and by reducing inherent uncertainties in the LRA. Both Tier I and Tier II LRAs for the Site used the same methods, but the Tier I screening LRA used upper bound assumptions regarding the potential for exposure concentrations and lower bound adverse effect concentrations. Thus, any LCOPCs that were eliminated in Tier I were done so with a high degree of certainty that adverse effects will not occur. The specific differences in assumptions between these two Tiers of the LRA are discussed in further detail in Section 5.2.2 (Exposure Analysis) and Section 5.2.3 (Effects Analysis).

The risk assessment process framework in this LRA consists of four phases: problem formulation, exposure analysis, effects analysis, and the risk characterization (**Figure A5-1**). Problem formulation is the first phase of the process where the problem (i.e., the purpose of the assessment) and the plan for analyzing and characterizing risk are defined. Discussion and planning among risk managers and risk assessors are important components of this phase of the LRA (**Figure A5-1**) and thus, are important to clarify during the work plan stage of the RI/FS process. The second step of the process is the exposure analysis phase in which potential exposures to environmental stressors are quantified. In the third phase of the process, effects analysis, the potential adverse effects to livestock from environmental stressors are identified and criteria for quantifying adverse effects are defined. During the fourth phase of the process, risk characterization, the exposure and effects analyses are integrated. In this phase, the likelihood of adverse effects occurring is estimated. Major uncertainties, assumptions, and strengths and limitations of the assessment are also summarized in the risk characterization. The methods that were used for each of the above phases of the LRA for the Site are described in the following subsections.

5.2.1 Problem Formulation

Problem formulation is a formal process for generating and evaluating preliminary hypotheses about the potential for adverse effects to receptors to occur. The primary components of problem formulation are:

- Identification of the system at risk
- Identification of stressor characteristics
- Identification of known effects
- Selection of assessment endpoints

- Construction of a CSM

These components of the problem formulation for the Henry Site are discussed below.

5.2.1.1 Environmental System at Risk

An environmental system is composed of biological, physical, and chemical elements that function together in a complex, inter-dependent manner. This section is organized into two categories: (1) biological system characteristics and (2) livestock species that potentially use the biological system.

Biological System Characteristics. The biological resources present on and in the vicinity of the Site are described in detail in Section 4.2.1.1. Following is a brief summary of the biological characteristics at the Site that are most relevant to potential livestock exposures.

Terrestrial - The plant communities present on the Site include sagebrush/grassland, aspen forest, mixed conifer/aspen forest, and riparian/wetlands. Of these plant communities, sagebrush/ grassland is primarily grazed. Dominant species within this community include big sagebrush, mountain snowberry, yellow rabbit brush, antelope bitterbrush and various forbs such as alfalfa, lupine, scorpion weed, white sage, sticky geranium, and mule's ears. Other common plant species at the Site include: western wheatgrass; orchard grass; cheatgrass; smooth brome; western yarrow; flatspine stickseed; and serviceberry.

Aquatic - An aquatic functional use survey of ponds (non-regulated surface water features) at the Sites conducted in June 2004 (IDEQ, 2004c) categorized all ponds into three tiers. Tier 1 ponds support aquatic-dependent wildlife; Tier 2 ponds are water features within grazing allotments, exhibiting livestock use or with reasonable potential for future livestock use; and Tier 3 ponds may be used as an occasional drinking water source by transitory terrestrial wildlife. As presented in **Table A4-8**, two of the four ponds at the Site (Henry Pond and Center Henry Pond) are categorized as Tier 1 ponds and one pond at the Site (Smith Pond) is Tier 2. The remaining pond (South Pit Pond) is categorized as Tier 3.

Livestock Grazing. Land within the Southeast Idaho phosphate resource area is managed by the state of Idaho, the USFS, and the BLM. There is also private land ownership, and parts of the area are developed and used for agriculture or grazing. Seasonal grazing by both sheep and cattle currently occurs on portions of the Site, but sustained grazing is not allowed. Horses are not currently grazed on the Site, and would only be allowed to under permission in the future; the most likely circumstance for horse grazing would be during movement or management of on-Site livestock.

5.2.1.2 Stressor Bioavailability and Exposure Routes

For toxicity to occur in a receptor, constituent exposure must occur, and must include a bioavailable fraction that can cause toxicity directly or indirectly through food web transfer. This section describes factors that affect the bioavailability of metals in terrestrial and aquatic environments based on potential routes of exposure to livestock. Drexler et al. (2003) provides a detailed review of factors affecting metals bioavailability in terrestrial and aquatic systems.

An overriding condition of metals exposure is that metals are naturally occurring and some are essential nutrients, such that plants and animals have evolved intricate strategies to balance nutrient levels and thus modulate exposures to metals (Drexler et al., 2003). These strategies may include: inhibited uptake, detoxification, storage, and increased elimination (Drexler et al., 2003). This LRA did not quantitatively examine the relative contribution of each of these strategies. However, measures of tissue concentrations, for example using sample results from terrestrial plants, provide the best quantitative measure of Site-specific exposure concentrations.

Terrestrial Environment. Cattle are exposed to soil contaminants through incidental ingestion of soil while foraging and consumption of contaminated plants. Transfer of contaminants through the food chain is a primary means by which animals are exposed to contaminants and is an integral part of risk assessment modeling practices developed by USEPA (USEPA, 1993; Drexler et al., 2003). Despite the occurrence of trophic transfer as an important and primary exposure route for animals, there are very few instances where metals have been found to biomagnify (i.e., increase in concentration with increasing trophic level) (Drexler et al., 2003). Selenium, a particular metal of concern for the Henry Site, can be both rapidly accumulated and rapidly excreted (approximately 70 to 80 percent) such that tissue body burdens may change within days and adverse effects from toxicity in adult animals may be reversed if the source of selenium exposure is eliminated (USDOI, 1998). In contrast, embryonic deformities due to selenium poisoning are not reversible.

Aquatic Environment. Water consumption is a potential contaminant exposure route for livestock. Sediment ingestion by livestock may occur incidentally during surface water consumption. As described above, there is one Tier 2 pond at the Site (Smith Pond) that has historically provided stock water.

5.2.1.3 Known Effects

High levels of selenium, unique from other metals, have been documented as toxic to livestock since the 19th century. In the SE Idaho phosphate mining region, several instances of selenium toxicity have been documented:

- December 1996: Six horses grazing on private land located downstream from the former South Maybe Canyon Phosphate Mine were diagnosed with chronic selenosis (selenium poisoning) and five of these horses had to be destroyed.
- Summer 1997: Two horses pastured on the former Conda Phosphate Mine were diagnosed with selenosis and both animals had to be destroyed. 176 sheep were found dead in the Conda Mine area. The cause of death was not confirmed, but selenium poisoning was a possibility. Since then, other occurrences of sheep deaths have been reported at the Conda and Wooley Valley Phosphate Mines. Forensic examination of samples taken in every case showed elevated selenium concentrations in tissue and rumen although definitive conclusions as to the actual cause of the deaths were not made. Myocardial necrosis, a symptom of toxic selenosis, was found in the Wooley Valley sheep (Buck and Jones, 2004).
- August 5, 2009: Eighteen cattle died of likely selenium poisoning near defunct Lanes Creek Mine in the Idaho Phosphate mining region (Miller, 2009).
- The weekend of October 6, 2012 a sheep owner and his employee moved a band of sheep onto the South Henry Mine Site without authorization from the land owner (P4). The sheep grazed on reclaimed areas and were then herded into an unfilled mine pit. The sheep consumed selenium-rich western aster, which resulted in the death of 95 animals from acute selenium poisoning (P4, 2013).
- In August 2015, three cattle thought to be grazing on State-Leased pasture land north of the Ballard Site, which is owned by P4, were found dead from suspected selenium poisoning. Soil and vegetation samples were collected north and south of the fence line separating the State pasture land from the Ballard Site, with elevated concentrations of selenium detected south of

the fence on P4 Property in a dozer-cut fire break line that was created during a 2012 range fire. It appears that the dozer cut exposed waste shale, and cow dung and grazed aster plants (a selenium hyperaccumulator) were observed at the location of the highest detected concentrations of selenium in soil and vegetation. P4 has repaired the portion of the fence that was breached by the cattle. Future corrective action includes seeking State approval to move the fence 20 feet to the north and enhancing the current fence inspection program to ensure that fences are inspected at least once per year and prior to the grazing season.

Efforts to understand the cause of these incidents were undertaken, and management practices have been implemented to prevent future occurrences of similar incidents.

5.2.1.4 Endpoint Receptor Selection

Endpoints define the focus of the LRA and include both assessment and measurement endpoints. Assessment endpoints are explicit statements about what aspects of the biological system (conditions or processes) are valued and intended for protection. Generally, assessment endpoints are populations or communities of receptors (USEPA, 1997c), and risk to assessment endpoints may not be directly quantifiable. Measurement endpoints are the various means by which the assessment endpoints are evaluated. Measurement endpoints are quantifiable indicators of the state of the assessment endpoint based on results of laboratory or field experimentation. The assessment endpoint for this LRA is the survival and health of livestock. The measurement endpoints used to evaluate livestock health are organismal scale effects which include, but are not limited to, mortality, growth, and reproductive impairment.

The primary livestock species that currently graze, or have historically grazed, on reclaimed mine sites in the Phosphate Resource Area are beef cattle and sheep. Due to the uncertainty in modeling uptake and effects to specific livestock animals, it was assumed that one livestock indicator receptor would be sufficient to quantify potential hazards to livestock. Sheep have a dietary preference for forbs that may include selenium hyperaccumulator species, and therefore toxic episodes involving sheep have occurred more frequently during authorized and unauthorized grazing at the Sites. Beef cattle are more sensitive to selenium toxicity than sheep are, but cattle have a preference for grasses. The Sites are particularly attractive for cattle grazing due to the grass mixtures that are used for re-vegetation during post-mining reclamation. Based on current and anticipated future beef cattle grazing uses of the reclaimed P4 Sites and the fact that horses do not graze on the P4 Sites beef cattle (*Bos taurus*) were selected as the indicator receptor for livestock in the LRA.

Measurement endpoints for the evaluation of potential acute effects of LCOPCs on beef cattle are HQs calculated based on a comparison of measured LCOPC concentrations in upland vegetation to available toxicity benchmarks for plants that are protective of livestock exposures. Measurement endpoints for the evaluation of potential chronic effects of LCOPCs on beef cattle are HQs calculated based on a comparison of modeled exposure doses in beef cattle to mammalian TRVs.

5.2.1.5 Conceptual Site Model

The culmination of problem formulation is the development of a site-specific CSM. The livestock CSM for the Site identifies the primary contaminant sources, release mechanisms, environmental transport mechanisms, secondary contaminant sources, and potential exposure routes for beef cattle. The livestock CSM for beef cattle developed for the Henry Site is depicted in **Figure A5-2**. The Henry Site has been re-vegetated, contains ample forage for beef cattle, and was sampled extensively for the metals that are the primary constituents of concern for the reclaimed phosphate mines. Exposure pathways between beef cattle and contaminated media at the Henry Site that were deemed to be 'complete' are: incidental ingestion of upland soil, consumption of upland vegetation, and consumption of surface water (**Figure A5-2**).

As noted in Section 5.2.1.2, there is one Tier 2 pond at the Site (Smith Pond) that has historically provided stock water. Therefore, surface water was included as an exposure medium. Sediment exposure pathways including incidental ingestion of sediment and consumption of aquatic plants were assumed to be 'potentially complete but insignificant' because exposure to sediment would be minimal in comparison to incidental ingestion of soil and consumption of terrestrial vegetation. Beef cattle would only be exposed to contaminants in groundwater where groundwater daylights to the surface as seeps or springs. However, surface water sampling results for seeps and springs are more representative of this scenario. Therefore, groundwater was assumed to be an incomplete exposure medium for beef cattle (**Figure A5-2**).

5.2.2 Exposure Analysis

Exposure analysis describes the manner in which estimates of potential exposure of receptors to Site contaminants are quantified. As described in Section 5.2, this LRA includes Tier I and Tier II assessments. In the Tier I assessment, EPCs were based on maximum detected concentrations. In the Tier II assessment, EPCs were derived as the upper bound average concentration. As described in Section 3.3.2.1, the UCL on the mean concentration of each LCOPC in each exposure medium was calculated using USEPA's ProUCL software version 5.0.00 (USEPA, 2013). This software calculates the UCL on the mean concentration based on the underlying distribution of the data. If a higher confidence than 95% (i.e., 97.5% or 99%) was recommended by ProUCL, the recommended UCL was utilized. Summary statistics and derived UCL on the mean concentrations for LCOPCs in applicable media are presented in **Table A3-8**, **Table A3-9**, and **Table A3-12** for the Henry Site and **Table A3-15**, **Table A3-16**, and **Table A3-19** for background. For LCOPCs without measured concentrations in upland vegetation, the same methods used to calculate modeled plant tissue concentrations described in Section 4.2.2.1 of the ERA were used to model plant tissue concentrations in the LRA.

5.2.2.1 Exposure Modeling

Dietary exposure modeling based on the USEPAs oral dose approach (USEPA, 1997c; 1993) was used to estimate exposures to beef cattle. The exposure model quantifies the dose (otherwise defined as the amount of constituent uptake from each relevant exposure medium). Uptake of contaminants is typically via three routes: ingestion, dermal absorption, and inhalation. For beef cattle, dermal absorption is of secondary importance due to the protection provided by fur and hooves. Inhalation is also deemed to be of secondary importance, because intake of wind-blown dust is expected to be much less than incidental ingestion of soil. Based on this rationale, the LRA for beef cattle was focused on ingestion exposure pathway, which includes ingestion of upland plants, ingestion of surface water, and incidental ingestion of soil. For beef cattle, the daily exposure to a LCOPC is expressed as the sum of the amount of the LCOPC consumed during the ingestion of food, water, and soil. The dose is quantified in milligrams of constituent ingested per kilogram body weight per day (mg/kg-bw/d) as described by the equation below (**Equation 45**).

(45) Beef Cattle Dose

$$= \frac{\left\lfloor\left(\sum \mathrm{IR_{plant}} \times \mathrm{F_{plant}} \times \mathrm{C_{plant}}\right) + \left(\sum \mathrm{IR_{abiotic}} \times \mathrm{C_{abiotic}}\right)\right\rfloor \times \mathrm{SUF} \times \mathrm{ED}}{\mathrm{BW}}$$

Where:

Beef Cattle Dose	= Dose of COPEC ingested (mg/kg-bw/day)
IR_{plant}	= Plant ingestion rate (kg/day)
F_{plant}	= Fraction of plants in diet (unitless)
C_{plant}	= LCOPC concentration in plants (mg/kg)
$IR_{abiotic}$	= Abiotic media (water and upland soil) ingestion rate (kg or L/day)
$C_{abiotic}$	= LCOPC concentration in abiotic media (mg/kg or mg/L)
SUF	= Site Utilization Factor (unitless)
ED	= Exposure duration (unitless)
BW	= Body weight of beef cattle (kg)

The remainder of this section describes the values selected for each of the exposure parameters noted above, which are also summarized in **Table A5-2**.

Food Ingestion Rate (FIR):

The preferred source of receptor-specific food ingestion rates (FIR) are species-specific feeding studies reported in the literature. If literature values for the ingestion rate of a receptor is not available, the ingestion rate may be calculated using allometric equations provided in the USEPA *Wildlife Exposure Factors Handbook* (USEPA, 1993) or more recently updated allometric equations (Nagy, 2001).

An allometric relationship is the relationship between an organism's body size and metabolic rate relative to some other biological parameter of the organism. The discussion of allometric equations in this LRA is limited to equations that describe the relationship of an organism's body size to its free-living metabolic rate (FMR). Multiple allometric equations have been developed separately for birds and mammals of various feeding guilds. The allometric equation selected for calculating the FIR for beef cattle is summarized below:

Cattle (Equation 29 for mammalian herbivore [Nagy, 2001]):

(46) $$\mathrm{FIR}\left(\frac{\text{g dry wt}}{\text{day}}\right) = (0.859 \times \mathrm{Wt(g)})^{0.628}$$

Where:

FIR	= food ingestion rate (g dry wt/day)
Wt	= average weight of indicator receptor (g)

Concentration in Dietary Items (C_{diet}):

Concentrations of LCOPCs in dietary items (i.e., upland plants) consumed by beef cattle were derived as described in Section 5.2.2.1, above.

Soil Ingestion Rate Calculations:

The fraction of soil in the diet was obtained from Beyer et al. (1994). The soil ingestion rate for elk was used as a surrogate soil ingestion rate for beef cattle, and was calculated using the equation below (**Equation 47**):

(47) $$\mathrm{IR_{soil}} = \mathrm{IR_{diet}} \times \mathrm{f_{soil}}$$

Where:

IR_{soil} = ingestion rate of soil (kg/day dry wt)
IR_{diet} = ingestion rate of dietary items (kg/day dry wt)
f_{soil} = fraction of soil in diet (% dry wt)

Water Ingestion Rate Calculations

The water ingestion (WI) rate is used to estimate exposure intake of LCOPCs through consumption of surface water. Water ingestion rates were calculated based on equations described in the *Wildlife Exposure Factors Handbook* (USEPA, 1993), as follows.

All mammals (Equation 3-17 [USEPA, 1993]):

(48)
$$\mathrm{WI}\left(\frac{L}{day}\right) = 0.099 \times Wt^{0.90}(kg)$$

Where:

WI = water ingestion rate
Wt = average weight of indicator receptor

Site Utilization Factor:

The receptor-specific SUF is used to quantify the amount of a site that is utilized by a receptor. If the receptor's range is smaller than the exposure area, the receptor is assumed to fulfill its forage and shelter requirements on the site and the SUF is therefore equal to one. If, however, the receptor's range is larger than the exposure area, the SUF is equal to the receptor's home range divided by the exposure area. The beef cattle SUF is assumed to be 1 for the purpose of conservatively evaluating future potential grazing landuse (**Table A5-2**). The exposure area for the Henry Site is 1,030 acres.

Exposure Duration:

The exposure duration is the fraction of the year that the receptor forages on Site. Beef cattle are assumed to graze the Henry Site 120 days each year, because snowpack and ice are present approximately six months of the year. Therefore, the exposure duration for beef cattle is 33% of the year (**Table A5-2**).

Receptor Body Weight:

A body weight for beef cattle of 510 kg (**Table A5-2**) was assumed based on a typical steer or heifer body weight at slaughter, as cited in Dhuyvetter (1995).

5.2.3 Effect Analysis

The effects analysis quantifies the relationship between exposures to a stressor and the harmful effects resulting from that exposure. The quantitative results of this analysis are termed TRVs. Mammalian TRVs are reported on a whole body burden basis to correspond to the exposure unit basis for which the TRVs are determined (i.e., the daily dose of a constituent). Two TRVs were identified for beef cattle: (1) the TRV_{NOAEL} is defined as the highest dose at which adverse effects are unlikely to occur; and (2) TRV_{LOAEL} is defined at the lowest dose where a specific biological effect is expected to occur. Exposure concentrations below the TRV_{NOAEL} with a high degree of certainty will not result in adverse effects, and exposure concentrations below the TRV_{LOAEL} are unlikely to result in adverse effects. Only the TRV_{NOAEL} was used in the Tier I screening evaluation, while both the TRV_{LOAEL} and the TRV_{NOAEL} were used to characterize the potential for adverse effects in the Tier II evaluation.

The TRVs for evaluating potential impacts of LCOPCs on beef cattle were obtained from the following hierarchy of sources:

4. USEPA EcoSSLs (USEPA, various dates)
5. ORNL (ORNL, 1996b)
6. Primary literature

The selected TRVs used to evaluate beef cattle are the mammal TRVs presented in **Table A4-19**.

Uncertainty Factors for TRVs:

LOAELs and other toxicity values with endpoints that reflect a level of impact are adjusted to a NOAEL-equivalent value through the application of UFs. In order to arrive at TRV_{NOAEL} values, ORNL (1996b) recommended applying a UF of 2 to adjust acute or subchronic endpoints to chronic endpoints. No UFs were applied to the TRVs that were selected from USEPA's EcoSSLs, as these studies have undergone extensive peer review, use a weight-of-evidence approach and the preponderance of all data, and the TRVs selected are intended to be protective of wildlife under chronic exposures.

A determination regarding whether or not a mammalian toxicity study represented subchronic or chronic exposures was based either on the duration of the experiment relative to the lifespan of the test species, or because the exposure occurred during a critical lifestage (e.g., mating, gestation, lactation). A mammalian toxicity study was determined to be chronic if exposure was at least 50 percent of a species' lifespan, based on technical support information presented in the Great Lakes Water Quality Initiative Wildlife Criteria (USEPA, 1995a; 1995b) and ORNL (1996b). For example, an exposure of one year or greater was considered to represent chronic exposure for studies on laboratory rodents, which have life spans of about two years. Reproductive and development periods (e.g., mating, gestation, or lactation) are particularly sensitive life stages due to the stressed condition of the adults and the rapid growth and differentiation occurring within the embryo (ORNL, 1996b). Because benchmarks are intended to evaluate the potential for adverse effects on wildlife populations, consistent with assessment endpoints in this ERA and ORNL (1996b), exposures that occurred during most of a species' reproductive or development period (i.e., critical life stage) were considered to represent chronic exposures.

5.2.4 Risk Characterization

Risk characterization is the final phase of risk assessment in which the likelihood of adverse effects is evaluated by combining results of the exposure analysis and effects analysis. Risk characterization consists of estimating and describing risk, including the assumptions and level of uncertainty associated with the risk estimate.

Acute Effects. In order to evaluate the potential acute effects of livestock exposure to selenium, measured selenium concentrations in upland vegetation at the Henry Site were compared to available toxicity information on livestock forage. Bollar et al. (undated) reported that acute selenium toxicosis in cattle is normally associated with forage-selenium concentrations in the range of 500 to 1,000 mg/kg. The maximum, 95% UCL and mean detected selenium concentration in all upland vegetation were 146 mg/kg, 14.6 mg/kg and 9.23 mg/kg, respectively. While the maximum detected concentration of selenium in upland vegetation is on the same order of magnitude as the bottom of the range of selenium concentrations in forage that are associated with acute cattle toxicosis, the 95% UCL and mean selenium concentrations in upland vegetation are much lower than the range of selenium concentrations in forage that are associated with acute cattle toxicosis. As a result, acute toxicity to livestock from exposure to selenium at the Henry Site is unlikely.

Chronic Effects. Potential chronic hazards to beef cattle involved the integration of modeled exposure estimates and constituent toxicity information discussed in Sections 5.2.2 and 5.2.3, respectively. Beef cattle exposure doses and toxicity data were integrated using **Equation 49** to calculate an HQ.

$$HQ = \frac{Dose}{TRV} \quad (49)$$

Where:

HQ	= Hazard quotient
Dose	= Total ingested daily dose of a constituent (mg/kg-d)
TRV	= Toxicity reference value (mg/kg-d)

The livestock HQ estimate calculations presented in Appendix J were performed using the full unrounded value of medium-specific dose estimates, although the values presented in Appendix J were rounded for display purposes. Media concentrations less than 100 were rounded to three significant figures and HQ estimates less than 10 were rounded to two significant digits. Media concentrations greater than 100 were rounded to the nearest whole number.

For both acute and chronic hazards, the livestock HQ is generally interpreted as follows:

- An $HQ_{NOAEL} < 1.0$ indicates that toxicological effects and potential risk are not likely to occur.
- An $HQ_{NOAEL} > 1.0$ and an $HQ_{LOAEL} < 1.0$ generally indicates that toxicological effects and potential risk to individual receptors are unlikely but may occur, provided there is a higher confidence in the toxicity values used and the LOAEL's magnitude relative to the NOAEL is considered.
- An $HQ_{LOAEL} > 1.0$ indicates that toxicological effects and potential risk to a receptor population may occur.

The most that can be concluded from a calculated HQ in excess of one is that there is an increased potential that an adverse effect may occur in at least one individual. While this potential increases as the magnitude of the HQ increases, the level of concern does not increase linearly with increases in HQ. This lack of linearity is based on the fact that typical dose response curves for constituents are not linear, but rather sigmoidal.

In those cases where $HQ_{NOAEL} > 1.0$ and an $HQ_{LOAEL} < 1.0$, the HQs were evaluated in the context of the representativeness of the constituent data sets and the quality of the available exposure and toxicity information.

5.3 Summary of Livestock Hazard Estimates

Potential hazards for beef cattle exposed to LCOPCs in environmental media at the Henry Site and background locations, are summarized in this section. Tier I and Tier II cumulative hazard estimates for the

Henry Site and background are presented in Sections 5.3.1 and 5.3.2, respectively. Detailed hazard estimate calculations are presented in **Attachment J**.

5.3.1 Tier I Beef Cattle Hazard Estimates

Tier I hazard estimates for beef cattle exposed to environmental media at the Henry Site and background locations are described below and summarized in **Table A5-3** through **Table A5-4**.

5.3.1.1 Henry Site

The NOAEL-based Tier I HQ estimates for beef cattle exposed to contaminated media at the Henry Site range from 0.000027 to 8.2, as shown in **Table A5-3**. Constituents with Tier I hazard estimate exceeding an HQ of 1 for beef cattle are molybdenum, selenium and thallium.

The NOAEL-based Tier I HQ estimates for beef cattle exposed to media at background sampling locations range from 0.000016 to 0.70, as shown in **Table A5-4**. These HQ estimates are all less than the hazard criterion of 1.

5.3.2 Tier II Beef Cattle Hazard Estimates

Constituents for which Henry Site NOAEL-based Tier I HQ estimates for beef cattle are less than 1 were eliminated from consideration in the Tier II LRA. Results of the Tier II LRA are described below.

The NOAEL-based Tier II HQ estimates for beef cattle exposed to contaminated media at the Henry Site range from 0.54 to 0.93, as shown in **Table A5-5**. These HQ estimates are all less than the hazard criterion of 1.

The NOAEL-based Tier II HQ estimates for beef cattle exposed to media at background sampling locations range from 0.042 to 0.066, as shown in **Table A5-6**. These HQ estimates are all less than the hazard criterion of 1.

The LOAEL-based Tier II HQ estimates for beef cattle exposed to contaminated media at the Henry Site range from 0.054 to 0.92, as shown in **Table A5-5**. These HQ estimates are all less than the hazard criterion of 1.

The LOAEL-based Tier II HQ estimates for beef cattle exposed to media at background sampling locations range from 0.0044 to 0.042, as shown in **Table A5-6**. These HQ estimates are all less than the hazard criterion of 1.

6.0 UNCERTAINTY ANALYSIS

The risk assessment process includes a series of conservative assumptions and input parameters that are designed to result in protective estimates of risk. There is inherent and intentional conservatism in this process, as well as uncertainty in the resulting risk estimates. To assist interpretation of the risk assessment results presented in this BRA, the primary sources of conservatism and uncertainty are described in Sections 6.1 and 6.2, respectively.

6.1 Primary Sources of Conservatism

Tier II cumulative media RME ILCR estimates for the Native American, hypothetical future resident, seasonal rancher, recreational hunter, recreational camper/hiker and recreational fisher calculated based on background concentrations of COPCs are 1×10^{-3}, 2×10^{-2}, 2×10^{-4}, 4×10^{-5}, 2×10^{-5}, and 3×10^{-5}, respectively. Background Tier II cumulative media RME HI estimates for the hypothetical future resident, Native American, seasonal rancher, recreational hunter, recreational camper/hiker and recreational fisher are 139, 125, 3, 0.009, 0.01 and 83, respectively. Background Tier II NOAEL-based ecological HQs for mammalian receptors ranged from 0.00056 (aluminum for the coyote) to 312 (thallium for the mink). The magnitude of the background risk and hazard estimates for some receptors, exposure pathways and constituents suggests that there is generally a high degree of conservatism in the BRA for the Henry Site. Primary sources of conservatism in the BRA for the Henry Site are as follows:

- The process used in selecting site COPCs may introduce a degree of uncertainty in the HHRA. However, protective methods and assumptions are used in selecting COPCs. Protective assumptions used in the COPC screening procedure include comparison of maximum detected constituent concentrations to one-tenth of the risk-based soil screening levels. Constituents that exceeded screening levels were further evaluated in the Tier I and Tier II HHRA.

- Secondary media pathways, including consumption of culturally significant plants, were evaluated for all constituents identified as COPCs in relevant primary media. As a result, exposure of a current / future Native American to antimony and thallium in culturally significant plant tissue was quantified in the HHRA, even though both of these constituents were sampled for, but not detected in culturally significant plant tissue. Risk and hazard estimates in the Tier I and Tier II HHRA were based on the maximum detection limits for these constituents.

- The process used in selecting site COPECs for evaluation of risks to ecological receptors may similarly introduce a degree of uncertainty in the ERA. Protective methods and assumptions were used in selecting COPECs, including screening maximum detected concentrations against conservative screening values. Constituents that exceeded screening levels, as well as constituents without applicable screening levels, were further evaluated in the Tier I and Tier II ERAs. Constituents without upland soil screening levels for upper trophic level receptors include boron, mercury, molybdenum, thallium, and uranium; these constituents exceeded the lower of the invertebrate and plant benchmarks but could not be screened for avian or mammalian receptors. Because these constituents could not be screened against applicable soil benchmarks, they were conservatively included in the ERA for upper trophic level receptors. Constituents without applicable sediment screening levels were boron, molybdenum, thallium, uranium, and vanadium. These constituents in sediment were also included in the ERA for upper trophic level receptors.

- The medium-specific EPCs used to quantify exposures for human, ecological, and livestock receptors may result in uncertainty in the exposure dose estimates. To address this potential uncertainty, 95% UCLs on the mean concentrations for Site COPCs, COPECs, and LCOPCs were used to estimate exposure doses for current and hypothetical future receptors exposed to Site-related media. Where the number of samples was insufficient to calculate 95% UCL on the mean concentrations, maximum concentrations were used to quantify exposure doses and risk estimates. Based on the above considerations, the exposure doses that were used in the BRA are believed to represent protective, upper bound estimates of exposure.

- The modeled COPC concentration for fruits and vegetables and edible culturally significant upland and riparian plants included a default mass loading factor soil-to-plant MLF that assumes that windblown contaminated soil accumulates on plant surfaces and is not washed off. The default MLF is based on data from soil accumulation on lettuce, which has a large surface area to mass ratio, and accounts for most of the modeled plant concentration for metals with low root uptake. It may be appropriate to evaluate exposures based on a less conservative MLF value. Where available, measured plant data were used instead of modeled plant data. These measured plant concentrations more accurately represent soil accumulation on plant surfaces; however, they do not accurately represent a scenario where the consumer washes plants before eating them.

- Exposure parameters used in dose modeling are intended to evaluate a worst-case scenario to provide an upper bound on ILCR and HI estimates. For example, the BRA assumes that a seasonal rancher resides at the Site during the period when cattle are grazing; 120 days under the RME exposure scenario, with direct contact to soil and groundwater every day. In reality, seasonal ranchers don't currently reside at the grazing allotments on the Site, nor are they likely to reside there in the future; rather, seasonal ranchers check on and tend to their cattle on an occasionally basis. These occasional visits by ranchers might include a day-long horseback ride through the cattle once every few weeks and a return to their off-Site home at the end of each Site visit. During those visits, they would bring their own water (and food) from off- Site because there are no suitable sources of drinking water on the Site.

- Background data for riparian soil, sediment, and vegetation represent only a portion of the potential area disturbed by historic mining, and likely do not adequately represent the entire geologic sequence (i.e., no Phosphoria Formation). As a result, background risk estimates for these media are most likely biased low, and corresponding incremental risk estimates for these media are probably biased high.

- Hazard associated with consumption of aquatic prey by ecological receptors was based on data from all surface water sampling locations, rather than only those locations where fish are present or are likely to be present, as ecological receptors might capture and consume prey from streams and springs too small to support game fish. Although hazards associated with receptors consuming aquatic prey are much lower when prey tissue concentrations are modeled from surface water sampling locations where fish are present or likely to be present, other pathways contribute to the total dose and only one constituent, copper, would no longer be a risk driver under this less conservative modeling scenario. It should be noted that compared with riparian soil, surface water contributes little to the ecological hazard estimate for copper, and the conservative inclusion of all surface water data in the dose therefore does not significantly impact the ERA conclusion.

- The HHRA assumes that all carcinogens do not have a threshold below which carcinogenic responses do not occur.

- Future land use at the Henry Site can affect the exposure area and concentrations for ecological receptors. For the ERA, the entire Henry Site areas were assumed to be accessible to ecological receptors, and as a result, the calculate ecological risks are protective of ecological receptors for all future land uses.

- Measured and upper bound average estimates of COPC and COPEC concentrations were used in risk and hazard calculations without accounting for a decrease in bioavailability due to adsorption to organic matter (in soil or sediment) or attenuation or dilution (in surface water). Additionally, toxicity values are generally derived from laboratory studies where readily absorbed forms of constituents are used, while under environmental conditions the constituent species may be less bioavailable. In this risk assessment, only the oral dose for arsenic in soil was adjusted for the RBA of arsenic in soil compared with arsenic in water that was used to develop the toxicity value. For all other COPCs, the RBA was assumed to be 100%. As a result, the human health and ecological risk and hazard estimates for other constituents may be overestimated.

6.2 Primary Sources of Uncertainty

The primary sources of uncertainty in the BRA for the Henry Site are as follows:

- A comparison of laboratory detection limits for non-detected metals to conservative screening levels was conducted as part of the data evaluation for the Henry Site.

  Detection limits exceeded ecological screening levels for antimony in upland soil, riparian soil, and sediment; boron in upland soil; and beryllium, boron, cobalt, and vanadium in surface water. With the exception of beryllium, which was never detected, these constituents were detected at concentrations above their detection limit, and therefore these potentially elevated detection limits for these metals had no effect on the selection of COPECs in relevant media for evaluation in the ERA. Beryllium was never detected in surface water samples; beryllium detection limits for nondetects exceeded the ecological Tier II SCV of 0.00066 mg/L (ORNL, 1996). The Tier II SCV value of 0.00066 mg/L is extrapolated from endpoints such as lethal concentration (LC) 50 and EC50, and is not an actual no effects concentration. An exceedance of the Tier II SCV does not indicate actual risks where additional data collection and assessment are necessary (ORNL, 1996). The maximum beryllium method detection limit (MDL) for nondetects of 0.002 mg/L is below the available lowest chronic values for fish (0.057 mg/L), daphnids (0.45 mg/L) and aquatic plants (100 mg/L) (ORNL, 1996), and as a result, beryllium concentrations at or below the detection limit of 0.002 mg/L are unlikely to affect the ecological risk estimates.

  Detection limits exceeded human health screening criteria for cobalt in surface water and arsenic, cadmium, chromium, cobalt, manganese, nickel, and vanadium in groundwater. Cobalt in surface water and arsenic, chromium, cobalt, and manganese in groundwater were detected at concentrations above their detection limits, and therefore these potentially elevated detection limits had no effect on the selection of COPCs in surface water or groundwater. Detection limits for cadmium, nickel, and vanadium exceeded screening levels in only two samples collected from the Henry Site in October, 2005. These two samples were associated with non-detect results for all metals except iron and zinc, which were detected well below their respective screening levels.

Detected concentrations and detection limits for cadmium, nickel, and vanadium were below screening levels in 56 additional samples for cadmium, and 31 additional samples for nickel and vanadium. Therefore, elevated detection limits in these two samples are unlikely to affect human health risk estimates.

- Antimony and thallium were identified as COPCs in upland soil and, therefore, they were also included in the quantitative evaluation for the consumption of culturally significant upland plants pathway. Both of these constituents were sampled for and not detected in upland culturally significant plant tissue at the Henry Site. Antimony was sampled for and not detected in culturally significant plant tissue collected from background sample locations. As a result, exposure to culturally significant plants harvested from upland soil was modeled from the maximum detection limit in both the Tier I and Tier II HHRAs. The maximum detection limit for antimony in background culturally significant upland plants is greater than the maximum detection limit in Henry Site culturally significant upland plants, and the single detection of thallium in background culturally significant upland plants is greater than the maximum detection limit for thallium in Henry Site culturally significant upland plants. Therefore, uncertainty and conservatism associated with evaluating consumption of culturally significant upland plants for antimony and thallium in the HHRA for a current/future Native American does not affect the final outcome of the HHRA for this receptor.

- The selection of ecological indicator receptors for evaluation of ecological risks in the ERA can be a source of uncertainty. However, ecological indicator receptors were chosen from different feeding guilds and the calculated risks should be representative of risks to other ecological receptors in similar feeding guilds.

- Potential uncertainties in the problem formulation phase of the ERA include, but are not limited to, ecological resources determined to be potentially impacted, applicable exposure pathways, exposure information and assumptions, and available contaminant characterization information.

- Concentrations of COPECs in biotic media were estimated using available BAFs when site-specific biota concentrations were not available, as described in Section 4.2.2. Uncertainty is associated with using BAFs obtained from primary literature because the data used to derive those BAFs could be obtained from sites with different environmental conditions than the Henry Site.

- Uncertainty is also associated with using soil-to-biota BAFs in place of sediment-to-biota BAFs due to complexities in the aquatic pathway that are not present in the terrestrial pathway. As a result, use of soil-to-biota BAFs in place of sediment-to-biota BAFs may underestimate bioaccumulation of COPECs in food items. The USEPA uses the linearized multistage (LMS) mathematical model to extrapolate animal toxicological data to human health toxicity values for carcinogens. The LMS model assumes that there is no threshold for carcinogenic substances. Several factors inherent in the LMS model that result in conservative carcinogenic potency include: (1) any exaggerations in the extrapolation that can be produced by some high dose responses (if they occur) are generally neglected; (2) upper confidence limits on the actual response observed in the animal study are used rather than the actual response, resulting in upper-bound low dose extrapolations, which can overestimate risk; and (3) non-genotoxic chemicals (i.e., threshold carcinogens) are modeled in the same manner as highly genotoxic chemicals. In general, a low to moderate uncertainty in the utilization of the USEPA LMS model is likely, resulting in an overestimation of risk to human health.

- Exposure of human, ecological, and livestock receptors to constituents other than selenium with detected concentrations in surface water above screening benchmarks was evaluated using dissolved concentrations. The surface water sampling program for the P4 Sites measures dissolved concentrations for all COPCs, except selenium, as described in the 2009/2010 Surface Water Sampling and Analysis Plan (MWH, 2009). In addition, background levels were developed for dissolved concentrations of all COPCs in surface water, with the exception of selenium, as described in the 2013 Background Levels Technical Memorandum (MWH, 2013). Although lower trophic level benchmarks for most metals in surface water are based on dissolved concentrations, upper trophic level ecological receptors and livestock are exposed to total metals concentrations. Additionally, human receptors exposed to surface water via incidental ingestion are exposed to total metals concentrations. Only arsenic was associated with an incremental ILCR above 1×10^{-6} following incidental ingestion of surface water; cumulative hazard estimates for all other COPCs were well below 1. Therefore, the conclusion of the HHRA (i.e., excess risk for arsenic in surface water) would not be impacted by the use surface water from unfiltered samples. No constituent was associated with excess ecological hazard for the direct surface water consumption pathway. Concentrations of COPECs in surface water were associated with excess hazard for the prey consumption pathway; however, the uncertainty in the factors used to model COPEC concentrations from abiotic media to biota is likely much more significant than uncertainty in the surface water concentration resulting from analyzing filtered samples.

- Ingestion rates for culturally significant plants and elk tissue used in the baseline risk assessment for the Henry Site were developed from the US EPA's Exposure Factor Handbook, but do not include the level of community-specificity information summarized in Shoshone-Bannock Tribes (2016). The RME vegetation ingestion rate of 293 grams, or approximately 10 ounces, per day for an adult is approximately double an ingestion rate of about 150 grams per day estimated from Attachment 1 of Shoshone-Bannock Tribes (2016). Because the Henry Site contains a limited amount of federally managed land where subsistence-level plant and game harvesting can occur, and all consumed vegetation was assumed to be comprised of Henry Site-derived culturally significant plants, the Native American plant consumption risk estimates presented in the Henry Mine RI Report are not believed to be significantly underestimated.

  Noncancer hazard estimates for ingestion of elk tissue based on an ingestion rate of 44.5 grams per day for an adult and the maximum detected concentration of metals in soil at the Henry Site range from 0.00000033 to 0.040; the cancer risk estimate for consumption of elk tissue is 7.2x10-7. Elk consumption rates estimated from Attachment 2 of Shoshone-Bannock Tribes (2016) range from 169 grams per day to 217 grams per day. Thus, the above supplemental cancer risk and noncancer hazard estimates for elk consumption by a Native American may be underestimated by a factor of about 4 – 5 times. Although the elk ingestion rates for the Native American may underestimate actual elk consumption rates based on the information included in Shoshone-Bannock Tribes (2016), the consumption of elk tissue is a minor contributor to overall risk compared with direct soil contact pathways. Thus while uncertainty in the elk tissue ingestion rate is high, uncertainty associated with the impact of this pathway on the overall conclusions of the baseline risk assessment is low.

- Incidental ingestion of soil by adults may occur when particles adhere to food, cigarettes, and hands; children likely have higher incidental soil ingestion exposures than adults due to deliberate hand-to-mouth movements, eating food off the floor, or placing objects from the floor in their mouths

(USEPA, 2011). As described in USEPA (2016d), fine (i.e., less than 150 micrometers [μm]) soil particles comprise the majority of soil adhering to skin. Additionally, studies indicate that soil particle size is inversely related to contaminant concentration (USEPA, 2016d). As a result, it is possible that incidental ingestion exposures that occur as a result of ingestion of soil on skin are underestimated at sites with course soil because the concentration of COPCs in soil on skin could be greater than the concentration of COPCs in an unsieved soil sample. Soil particle size was not measured during the Henry Site RI consistent with the Ballard, Henry and Enoch Valley Mines, Remedial Investigation and Feasibility Study Work Plan (MWH, 2011) and, thus, potential bias associated with particle size cannot be estimated. It should be noted that although studies demonstrate that smaller soil particles are more likely to adhere to skin, and have higher concentrations of some contaminants, studies have not been conducted to describe the size of particle most likely to be ingested during hand-to-mouth activity. In addition, soil ingestion rates are based, in part, on tracer studies that might implicitly account for particle size.

- Dermal toxicity criteria are not available from USEPA. Typically, a simple route-to-route (oral-to-dermal) extrapolation is assumed such that the available oral toxicity criteria (RfD and CSF) are used to quantify potential effects associated with dermal exposure. However, as noted in the USEPA's Risk Assessment Guidance for Superfund, Part E Supplemental Guidance for Dermal Risk Assessment (USEPA 2004), depending upon the COPC being evaluated, there is uncertainty and underestimation of risk and hazard to human health associated with this approach because the oral toxicity criteria are based on an administered dose and not an absorbed dose. In general, USEPA guidance recommends an adjustment of the oral toxicity criteria to convert an administered dose to an absorbed dose (USEPA, 2004). The adjustment accounts for the absorption efficiency of the constituent in the "critical study" that is the basis of the oral toxicity criterion. If the oral absorption in the critical study is 100 percent, then the absorbed dose is equivalent to the administered dose and no adjustment is necessary. If the oral absorption of a constituent in the critical study is poor (i.e., less than 50 percent), then the absorbed dose is much smaller than the administered dose. In this situation, an adjustment to the oral toxicity criteria is recommended.

- Dermal and inhalation exposure pathways for surface-dwelling animals were not included in the ERA. As presented in Section 4.2.2.5, dermal absorption is of secondary importance to exposure due to the protection provided by fur, feathers, and for some species, scaly skin. Furthermore, constituents that are present on the exterior of an organism are often consumed during routine cleaning or, for aquatic organisms, simply washed away. For mammals and birds, exposure to constituents from inhalation is also deemed to be of secondary importance. Based on this rationale, risk assessment for vertebrate wildlife was focused on ingestion exposure pathways such as the ingestion of food, water, or soils/sediments. As a result, the uncertainty in not evaluating the dermal and exposure pathways for surface-dwelling animals in the ERA is considered to be low. Additionally, given that the dermal and inhalation exposure pathways are deemed to be of secondary importance, underestimation of hazards to ecological receptors is considered to be low.

- TRVs for evaluating potential effects of COPECs on ecological endpoint receptors were obtained from the hierarchy of toxicological sources described in Section 4.2.3. TRVs for all mammalian and avian receptors were based on available general mammalian and avian TRVs, respectively. Uncertainties are associated with using TRVs that were derived from toxicological studies on test species that are different from the endpoint receptors evaluated in the ERA.

- Extrapolation of toxicological data from animal tests is a significant source of uncertainty in a HHRA, with a moderate underestimation or overestimation (depending on the constituent) of risk in the HHRA. In the establishment of the non-carcinogenic toxicity values, multipliers, modifying factors are applied to the NOAEL or LOAEL. For example, an uncertainty factor of 1,000 means that the dose corresponding to a toxicological effect level is divided by 1,000 to establish a safe, or "reference," dose. The purpose of the modifying factor is to account for the extrapolation of toxicity data from animals to humans and to ensure the protection of sensitive individuals.

- Toxicity values (i.e., TRVs) for evaluating potential effects of COPECs on ecological receptors were obtained from the hierarchy of toxicological sources described in Section 4.2.3. Fewer published TRVs are generally available for avian receptors than are available for mammalian receptors. As a result, ecological hazards for birds could not be quantified for several COPECs due to a lack of avian TRVs for these constituents.

- Area-averaging of data over the entire Site potentially underestimates exposures to receptors with small foraging areas. However, the Tier I and Tier II ecological hazard estimates were calculated specifically to provide a range of values for hazard evaluations. Tier I hazard estimates were based on maximum detected concentrations, while Tier II hazard estimates used the lower of the maximum detected concentration or 95% UCL on the mean concentration measured in surface soil samples collected from Henry Site sampling locations. Additionally, only the TRV_{NOAEL} was used in the Tier I screening evaluation, while both the TRV_{LOAEL} and the TRV_{NOAEL} were used to characterize the potential for adverse effects in the Tier II evaluation. Exposure concentrations below the TRV_{LOAEL} are unlikely to result in adverse effects and exposure concentrations below the TRV_{NOAEL} with a high degree of certainty will not result in adverse effects. As a result, the hazard estimates for ecological receptors with smaller foraging ranges would likely fall between the Tier I and Tier II hazard estimates, and the likelihood that risks to ecological receptors with smaller home range would be underestimated is low.

- Risks to future workers were not evaluated quantitatively in the HHRA. The exposure pathways applicable to future workers include direct contact soil pathways and ingestion of potable groundwater. These pathways were evaluated for the hypothetical future resident. The exposure assumptions for the hypothetical future resident are more conservative than those for future workers. As a result, the estimated risks and hazards for the hypothetical future resident would be protective of potential risks and hazards to future workers.

- It is possible that some biota consumption pathways not quantitatively evaluated for a particular receptor could be applicable to that receptor. For example, a hypothetical future resident and a recreational camper/hiker could also hunt, and a hypothetical future resident could also consume aquatic plants. The uncertainty in estimated human health risks for these additional biota pathways are low because these additional pathways are evaluated for other receptors such as the recreational hunter and Native American.

- Amphibians and fish in aquatic environments could be exposed to COPECs, including selenium, in prey items. Chapman et al. (2010) also notes that even though significant uptake of selenium through food items is possible, much more research is needed to be able to adequately quantify selenium uptake and the resulting hazards that dietary uptake poses to amphibians and fish. However, because the comparison of measured COPECs in surface water to water quality criteria is based on chronic aquatic life criteria, the hazard estimates calculated for amphibians and fish is therefore expected to be protective of both acute and chronic effects. As a result, any possible underestimation of risk to juvenile or adult amphibian and fish consumers is likely to be low.

- Wildlife and livestock exposure models that do not include potential COPC concentrations in milk vetch or other selenium hyperaccumulators may underestimate exposure associated with consumption of these plant species.

- The primary livestock species that currently graze, or have historically grazed, on reclaimed mine sites in the Phosphate Resource Area are beef cattle and sheep. Sheep have a dietary preference for forbs that may include selenium hyperaccumulator species, and therefore toxic episodes involving sheep have occurred more frequently than toxic episodes involving other livestock species during authorized and unauthorized grazing at the Sites. Beef cattle are more sensitive to selenium toxicity than sheep are, but cattle have a preference for grasses and the Sites are particularly attractive for cattle grazing due to the grass mixtures that are used for re-vegetation during post-mining reclamation.

7.0 CONCLUSIONS

This BRA Appendix was prepared to evaluate the potential for adverse effects on human, ecological, and livestock receptors associated with residual contamination from historic mining activities at the Henry Site, and to identify risk drivers for further evaluation in the RI. As indicated in the following subsections, Tier II cancer risk and noncancer hazard estimates in excess of IDEQ and USEPA criteria were calculated for multiple human and ecological receptors, while no excess Tier II hazard estimates were calculated for livestock. Human receptors with the highest risk estimates are those with the most conservative exposure scenarios (i.e., hypothetical future residents, Native Americans, and seasonal ranchers) while receptors with more realistic exposures (i.e., recreational hunters, recreational camper / hikers, and recreational fishers) were associated with lower excess incremental risk estimates and no excess incremental hazard estimates. All ecological receptors, except the elk and raccoon, had excess hazard estimates associated with exposure to one or more metal(s) in one or more media.

7.1 Tier I Human Health Risk Summary

Tier I, screening-level HHRA risk estimates were calculated for a Native American, hypothetical future resident, and seasonal rancher exposed to COPCs in environmental media at the Henry Site and background locations, based on RME assumptions (**Table A7-1**). Tier I RME ILCR and noncancer HI estimates for all three of these receptors were in excess of IDEQ's and USEPA's acceptable risk criteria of 1 x10^{-5} and 1 x 10^{-4} to 1 x 10^{-6}, respectively, and acceptable noncancer HI of 1 as described in Section 3.4.1. It is worth noting that Tier I RME ILCR and noncancer HI estimates calculated for the above receptors using background concentrations were also in excess of IDEQ's and USEPA's acceptable cancer risk and noncancer hazard criteria. Based on results of the Tier I HHRA, the Henry Site was further evaluated in a Tier II HHRA.

7.2 Tier II Human Health Risk Summary

Tier II, baseline HHRA risk estimates were calculated for a Native American, hypothetical future resident, seasonal rancher, recreational hunter, recreational camper/hiker, and recreational fisher exposed to COPCs in environmental media at the Henry Site, based on both RME and CTE assumptions. Tier II baseline HHRA risk estimates were also calculated for these receptors based on background concentrations of COPCs under RME assumptions, and incremental risk estimates above background were calculated. Henry Site and incremental Tier II RME ILCR estimates for the Native American, hypothetical resident, and seasonal rancher are in excess of IDEQ's and USEPA's acceptable risk criteria. Henry Site and incremental Tier II RME ILCR estimates for the recreational hunter and recreational camper / hiker are in excess of IDEQ's acceptable risk criteria, but within the USEPA's acceptable risk range. For the recreational fisher, Henry Site Tier II RME ILCR estimates are in excess of IDEQ's acceptable risk criteria, but within the USEPA's acceptable risk range; incremental Tier II RME ILCR estimates for this receptor are below both IDEQ's acceptable risk criteria and the USEPA's acceptable risk range. Henry Site and incremental Tier II noncancer HI estimates for the Native American, hypothetical future resident, and rancher receptors are in excess of IDEQ's and USEPA's acceptable criterion for noncancer effects. The Henry Site Tier II noncancer HI estimate for a recreational fisher is in excess of IDEQ's and USEPA's acceptable criterion, while the incremental HI for this receptor is not. The Henry Site and incremental Tier II RME noncancer HI estimates for the recreational hunter and recreational camper/hike are below IDEQ's and USEPA's acceptable hazard criterion. Tier II RME risk drivers for each receptor and medium are presented in **Table A7-2**.

Primary risk drivers for direct exposure pathways are arsenic in upland soil, surface water, and groundwater; radium-226 in upland soil, radon-222 in indoor air, and cobalt and thallium in groundwater. With the exception of radium-222 and cobalt, these constituents, along with cadmium, molybdenum, selenium, vanadium, and zinc, are also risk driver for one or more indirect pathways associated with biota uptake.

7.3 Tier I Ecological Hazard Summary

Tier I NOAEL-based screening-level ecological hazard estimates were calculated for amphibians and fish exposed to COPECs in surface water at the Henry Site, and for terrestrial and riparian upper trophic level ecological receptors exposed to combined media at the Henry Site and background locations. Constituent-specific HQs for amphibians and fish exposed to surface water COPECs at the Henry Site in excess of IDEQ's and USEPA's acceptable hazard criterion of 1 were calculated for aluminum, barium, boron, cadmium, manganese, nickel, selenium, uranium, vanadium, and zinc, as shown in **Table A4-21**. NOAEL-based Tier I HQ estimates in excess of 1 were calculated for the following terrestrial receptors at the Henry Site: long-tailed vole, American goldfinch, deer mouse, raccoon, American robin, mallard, mink, coyote, great blue heron, and northern harrier, as shown in **Table A7-3**. NOAEL-based Tier I HQ estimates for the elk are below 1. Tier I risk drivers for each receptor are also presented in **Table A7-3**. Constituents with NOAEL-based Tier I ecological HQ estimates in excess of 1 for various receptors at the Henry Site are: aluminum, antimony, arsenic, cadmium, chromium, copper, molybdenum, nickel, selenium, thallium, uranium, vanadium, and zinc.

Endpoint-specific, NOAEL-based Tier I HQ estimates in excess of 1 were calculated for the following receptors at background locations: long-tailed vole, American goldfinch, deer mouse, raccoon, American robin, mallard, mink, coyote, and northern harrier. NOAEL-based Tier I ecological HQ estimates for the elk and great blue heron exposed to media at background locations are below 1. Constituents with NOAEL-based Tier I ecological HQ estimates in excess of 1 for various receptors exposed to media at background locations are: aluminum, antimony, cadmium, chromium, copper, molybdenum, nickel, selenium, vanadium, thallium, uranium, and zinc.

7.4 Tier II Ecological Hazard Summary

Tier II NOAEL-based and LOAEL-based ecological hazard estimates were calculated for terrestrial upper trophic level ecological receptors exposed to combined media at the Henry Site and background locations. NOAEL-based Tier II HQ estimates in excess of 1 were calculated for the following receptors at the Henry Site: long-tailed vole, American goldfinch, deer mouse, raccoon, American robin, mallard, mink, coyote, and great blue heron, as shown in **Table A7-4**. COPECs with NOAEL-based Tier II ecological HQ estimates in excess of 1 are: aluminum, antimony, cadmium, chromium, copper, molybdenum, nickel, selenium, thallium, vanadium, and zinc. LOAEL-based Tier II ecological HQ estimates in excess of 1 were calculated for the following receptors at the Henry Site: long-tailed vole, American goldfinch, deer mouse, American robin, mallard, mink, coyote, great blue heron, and northern harrier; LOAEL-based Tier II HQ estimates for the raccoon are below 1. COPECs with LOAEL-based Tier II HQ estimates in excess of 1 are: aluminum, cadmium, chromium, copper, molybdenum, nickel, selenium, thallium, vanadium, and zinc.

NOAEL-based Tier II ecological HQ estimates in excess of 1 were calculated for the following receptors at background locations: long-tailed vole, American goldfinch, deer mouse, raccoon, American robin, mink, and coyote; background NOAEL-based Tier II ecological HQ estimates for the raccoon, mallard, coyote, great blue heron and northern harrier are below 1. COPECs with background NOAEL-based Tier II ecological HQ estimates in excess of 1 are: aluminum, antimony, cadmium, chromium, copper, molybdenum, nickel, selenium, thallium, and vanadium. LOAEL-based Tier II ecological HQ estimates in excess of 1 were calculated for the following receptors at background locations: long-tailed vole, American goldfinch, deer mouse, American robin, and mink; background LOAEL-based Tier II HQ estimates for the raccoon, mallard, coyote, great blue heron, and northern harrier are below 1. COPECs with background LOAEL-based Tier II ecological HQ estimates in excess of 1 are: antimony, aluminum, cadmium, chromium, copper, nickel, selenium, thallium, and vanadium.

As noted in Section 4.3.3, ecological hazard estimates associated with antimony in upland soil, and antimony and thallium in riparian soil, were greater at background locations than at Henry Site locations; therefore, antimony and thallium are not listed as Henry Site risk drivers for these media in **Table 7-4**. The most significant risk drivers for ecological receptors are selenium and thallium in upland soil. Additional risk drivers include molybdenum in upland and riparian soil; nickel in upland and riparian soil, and sediment; selenium in riparian soil, sediment, and surface water (in addition to upland soil); vanadium in upland and riparian soil; and zinc in upland soil and sediment.

7.5 Livestock Hazard Summary

NOAEL-based Tier I HQ estimates in excess of 1 were calculated for cattle at the Henry Site for molybdenum, selenium, and thallium, as shown in **Table A7-5**. NOAEL-based and LOAEL-based Tier II HQ estimates in for cattle at the Henry Site were below 1.

NOAEL-based Tier I, NOAEL-based Tier II and LOAEL-based Tier II HQ estimates were below 1 for cattle at background locations.

8.0 REFERENCES

Adams, W. J., W. J. Berry, G.A. Burton Jr., K. Ho, D. MacDonald, R. Scroggins, and P.V. Winger. 2001. Summary of a SETAC Technical Workshop Porewater Toxicity Testing: Biological, Chemical, and Ecological Considerations with a Review of Methods and Applications, and Recommendations for Future Areas of Research. R.S. Carr and M. Nipper (Eds.). SETAC Press, Pensacola, FL.

Agency for Toxic Substances and Disease Registry (ATSDR). 2006. Public Health Assessment for Bannock, Bear Lake, Bingham, and Caribou Counties, Idaho. EPA Facility ID: IDN001002245. United States Department of Health and Human Services (USDHHS). February 24.

ATSDR. 2013. Toxicological profile for Uranium. February.

Allen, HE. 2002. Bioavailability of metals in terrestrial ecosystems: Importance of partitioning or bioavailability to invertebrates, microbes and plants. Society of Environmental Toxicology and Chemistry. Pensacola, FL: SETAC Press.

Baes, C. F., III, R.D. Sharp, A.L. Sjoreen, and R.W. Shor (Baes, et al.). 1984. A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture. ORNL-5786. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Baker, A., R. Brooks, and R. Reeves. 1988. Growing for gold…and copper…and zinc. New Scientist 117:44-48.

Barnett, M. and A. Hawkins. 2008. The Effect of Soil Properties on Toxic Metal Bioavailability: Field Scale Validation to Support Regulatory Acceptance. DOD-EPA-DOE Environmental Security Technology Certification Program (ESTCP). Available at: http://www.esd.ornl.gov/research/earth_sciences/images/effect_soil_properties.pdf.

Bechtel Jacobs. 1998a. Biota-sediment Accumulation Factors for Invertebrates: Review and Recommendations for the Oak Ridge Reservation. Prepared for Oak Ridge National Laboratory, Oak Ridge, TN.

Bechtel Jacobs. 1998b. Empirical models for the uptake of inorganic chemicals from soil by plants. Prepared for Oak Ridge National Laboratory, Oak Ridge, TN.

Beyer, W.N., E. Connor, and S. Gerould (Beyer, et al.). 1994. Estimates of Soil Ingestion by Wildlife. J. Wildl. Manage. 58:375-382.

Bollar, J.V., E.D. Duren, and S. MacGregor. Undated. *Selenium – Livestock Grazing & Mining*. Prepared for the Idaho Mining Association.

Buchman, M.F. 2008. National Oceanic and Atmospheric Administration (NOAA) Screening Quick Reference Tables. NOAA OR&R. Report 08-1. Seattle WA, Office of Response and Restoration Division, 34 pp.

Buck, B.W. and J.L. Jones. 2004. Response to Selenium Contamination at Phosphate Mines in Southeastern Idaho. Available on the USDA Forest Service web site at: http://www.fs.fed.us/geology/buck-jones.pdf#xml=http://www.fs.fed.us/cgi-bin/texis/searchallsites/search.allsites/xml.txt?query=selenium&db=allsites&id=4a476a910.

CH2M Hill. 2013. Comprehensive Data Quality Objects, RCRA Facility Investigation, Santa Susana Field Laboratory, Ventura County, California. March.

CH2M Hill. 2015. Appendix E: Summary of Literature-Derived Fish Tissue Toxicity Data for the Baseline Ecological Risk Assessment, Halaco Superfund Site, Oxnard, California. September.

Chapman, P.M., W.J. Adams, M. L. Brooks, C. G. Delos, S. N. Luoma, W. A. Maher, H. M. Ohlendorf, T. S. Presser and D. P. Shaw. 2009. Ecological Assessment of Selenium in the Aquatic Environment: Summary of a SETAC Pellston Workshop.

Cornell Lab of Ornithology web site. http://www.birds.cornell.edu.

Drexler, J., N. Fisher, G. Henningsen, R. Lanno, J. McGeer, and K. Sappington. 2003. Issue paper on the bioavailability and bioaccumulation of metals. Submitted to U.S. Environmental Protection Agency, Risk Assessment Forum, Washington, D.C. August.

Dhuyvetter, John. 1995. Beef Cattle Frame Scores. North Dakota State University Agriculture and University Extension. May. http://www.ag.ndsu.edu/pubs/ansci/beef/as1091w.htm

Formation Environmental. 2016. Final Conda/Woodall Mountain Mine RI/FS Site-Specific Livestock Risk Assessment Report. June.

Grill, E. E.L. Winnacker, and M.H. Zenk. 1985. Phytochelatins: The principal heavy metal complexing peptides of higher plants. Science. 230:674-676.

Idaho Administrative Code (IAC) 2009a. Water Quality Standards. IDAPA 58.01.02.

IAC. 2009b. Groundwater Quality Rule. IDAPA 58.01.11

Idaho Department of Environmental Quality (IDEQ). 2004a. Idaho Risk Evaluation Manual. Final.

IDEQ. 2004b. Area Wide Risk Management Plan for Southeast Idaho Phosphate Mining Resource Area.

IDEQ. 2004c. Interagency non-regulated surface water inspection results for P4 Production's Ballard, Henry, and Enoch Valley Mine Sites. Memorandum from Rick Clegg, IDEQ to Robert Geddes, P4, dated June 23, 2004.

Idaho digital atlas: http://imnh.isu.edu/digitalatlas/bio/mammal/mamfram.htm

Jarvinen, A.W. and G.T. Ankley. 1999. Linkage of effects to tissue residues: development of a comprehensive database for aquatic organisms exposed to inorganic and organic chemicals. Society of Environmental Toxicology and Chemistry (SETAC). Pensacola, FL. 364 pp. As cited in the USEPA's Toxicity / Residue Database.

Kuck. 2003a. An Evaluation of the Effects of Selenium on Elk, Mule Deer, and Moose in Southeastern Idaho.

Kuck. 2003b. The Management of Big Game Populations, Their Habitat, and Selenium in Southeast Idaho.

Lasat, M.M. 2000. Phytoextraction of metals from contaminated soil: a review of plant/soil/metal interaction and assessment of pertinent agronomic issues. J. of Hazard. Subst. Res. 2:1-25.

Limas, B. 2001. "Circus cyaneus" (On-line), Animal Diversity Web. Accessed February 16, 2010. http://animaldiversity.ummz.umich.edu/site/accounts/information/Circus_cyaneus.html

MacCracken and Hansen. 1982. Seasonal Foods of Coyotes in Southeastern Idaho: A Multivariate Analysis.

Miller, J. 2009. Selenium suspected in cattle deaths near Idaho mine. The Salt lake Tribune. August 14, 2009.

Montgomery Watson (MW). 1999. Draft – 1998 Regional Investigation Report, Southeast Idaho Phosphate Resource Area. Prepared for Idaho Mining Association Selenium Subcommittee. June.

MWH. 2007. Interim Phase I SIs Evaluation Summary (Draft), Prepared by MWH for P4 Production, Southeast Idaho Mine-Specific Selenium Program, November 2007.

MWH, 2009. 2009 and 2010 Surface Water Monitoring Sampling and Analysis Plan, Final Revision 2. Prepared by MWH for P4 Production, May 2009.

MWH, 2011. Ballard, Henry and Enoch Valley Mines, Remedial Investigation and Feasibility Study Work Plan. Final. May 2011.

MWH. 2013. Background Levels Development Technical Memorandum: Ballard, Henry, and Enoch Valley Mines (Final), Prepared by MWH for P4 Production, Southeast Idaho Mine-Specific Selenium Program, March 2013.

MWH and CH2M Hill. 2011. Inhalation Toxicity Reference Value Updates for Use in Ecological Risk Assessments at the Santa Susana Field Laboratory, Ventura County California.

Nagy, K. A. 1987. Field metabolic rate and food requirement scaling in mammals and birds. Ecol. Monogr. 57: 111-128.

Nagy, K. A. 2001. Food requirements of wild animals: predictive equations for free-living mammals, reptiles, and birds. Nutritional Abs. & Rev. Series B: Livestock Feeds and Feeding 71(10):1R-12R.

Oak Ridge National Laboratory (ORNL). 1996a. Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Aquatic Biota: 1996 Revision. ES/ER/TM-96/R2.

ORNL. 1996b. Toxicological Benchmarks for Wildlife: 1996 Revision. ES/ER/TM-86/R3

ORNL. 1997a. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. ES/ER/TM-85/R3.

ORNL. 1997b. Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision. ES/ER/TM-126/R2.

ORNL. 1997c. Preliminary Remediation Goals for Ecological Endpoints. ES/ER/TM-162/R2.

Pascoe et al. (1996) as cited in the Area Wide Risk Management Plan for the Southeast Idaho Phosphate Mining Resource Area (IDEQ, 2004).

Presser, T.S. and S. N. Luoma. 2010. A methodology for Ecosystem-Scale Modeling of Selenium. Integrated Environmental Assessment and Management. 6(4):685-710.

PTI. 1995. Bioaccumulation Factor Approach Analysis for metals and Polar Organic Compounds. Submitted to: Washington Department of Ecology, Center Program, Environmental Review and Sediment Section. CAOU-03-03. October.

Risk Assessment Information System (RAIS). 2013. http://rais.ornl.gov/.

Sample, B. E., J. J. Beauchamp, R. A. Efroymson, and G. W. Suter. 1998a. Development and Validation of Bioaccumulation Models for Earthworms. ES/ER/TM-219. Oak Ridge National Laboratory.

Sample, B. E., J. J. Beauchamp, R. A. Efroymson, and G. W. Suter. 1998b. Development and Validation of Bioaccumulation Models for Small Mammals. ES/ER/TM-219. Oak Ridge National Laboratory.

Sample et al., 1999. Literature-derived bioaccumulation models for earthworms.

Schafer, E.W., Jr., W.A. Bowles, Jr., and J. Hurlbut. 1983. The acute oral toxicity, repellency, and hazard potential of 998 chemicals to one or more species of wild and domestic birds. Arch. Environm. Contam. Toxicol. 12:355-382.

Senseman, R. 2002. "Cervus elaphus" (On-line), Animal Diversity Web. Accessed February 22, 2011. http://animaldiversity.ummz.umich.edu/site/accounts/information/Cervus_elaphus.html.

Slater, G.L., and C. Rock. 2005. Northern Harrier (*Circus cyaneus*): a technical conservation assessment. USDA Forest Service, Rocky Mountain Region, Species Conservation Project. 38 pp.

Stalcup, D. 2016. Considering a Noncancer Oral Reference Dose for Uranium for Superfund Human Health Risk Assessments. Washington, DC, Office of Land and Emergency Management: p. 6, plus attachment. https://semspub.epa.gov/work/HQ/196808.pdf

Tetra Tech EM Inc. 2002. Final Area-wide human health and ecological risk assessment. Selenium Project southeast Idaho phosphate mining resource area. Prepared for Idaho Department of Environmental Quality. December

U.S. Army Corps of Engineers (USACE) - Portland District Seattle District, Walla Walla District, and Northwestern Division, U.S. Environmental Protection Agency (USEPA) Region 10, Washington Department of Ecology (Ecology), Washington Department of Natural Resources (WDNR), Oregon Department of Environmental Quality (ODEQ), IDEQ, National Marine Fisheries Service (NMFS), and U.S. Fish and Wildlife Service (USFWS). (USACE et al.) 2009. Sediment Evaluation Framework for the Pacific Northwest. May.

USACE. 2010. The Environmental Residue-Effects Database (ERED). Last Data Update: October 2010. : http://el.erdc.usace.army.mil/ered/index.cfm

United States Department of the Interior (USDOI). 1998. Guidelines for Interpretation of the Biological Effects of Selected constituents in Biota, Water, and Sediment. Selenium. National Irrigation Water Quality Program Information Report No. 3. November.

United States Environmental Protection Agency (USEPA), 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. October

USEPA. 1989. Risk Assessment Guidance for Superfund (RAGS). Volume I: Human Health Evaluation Manual (Part A), Interim Final, USEPA/540/1-89/002. December.

USEPA. 1991a. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors.

USEPA. 1991b. Role of the Baseline Risk Assessment in Superfund Remedy Selection Decision, OSWER Directive 9355.0-30.

USEPA. 1992a. Guidance for Data Useability in Risk Assessment (Part A) Final. April.

USEPA. 1992b. Final Exposure Assessment Guidelines. EPA/600/Z-92/001. May.

USEPA. 1993. Wildlife Exposure Factors Handbook. EPA/600/R-93/187. December.

USEPA. 1995a. Final Water Quality Guidance for the Great Lakes System; Final Rule - Part III - 40 CFR 9, 122, 123, 131, and 132. 60FR15365.

USEPA. 1995b. Great Lakes Water Quality Initiative Technical Support Document for Wildlife Criteria. EPA-820-B-95-009. March.

USEPA. 1996. Soil Screening Guidance: Technical Background Document. EPA/540/R95/128. May.

USEPA. 1997a. Annual Health Effects Assessment Summary Tables (HEAST) FY 1997. Office of Solid Waste and Emergency Response, Washington DC. EPA 540/R-94/036.

USEPA. 1997b. Exposure Factors Handbook 1997. Office of Emergency and Remedial Response. USEPA/600/P-95/002 Fa. August.

USEPA. 1997c. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments. Interim Final. EPA 540-R-97-006. June.

USEPA. 1999. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities. Peer Review Draft. EPA530-D-99-001A.

USEPA. 2000. Bioaccumulative Testing and Interpretation for the Purpose of Sediment Quality Sediment Quality Assessment, Status and Needs, EPA-823-R-00-001, February.

USEPA. 2003. Human Health Toxicity Values in Superfund Risk Assessments. Office of Solid Waste and Emergency Response 9285.7-53. December.

USEPA. 2004. Risk Assessment Guidance for Superfund (RAGS) Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). USEPA/540/R/99/005.

USEPA. 2005a. Guidelines for Carcinogen Risk Assessment. EPA/630/P-03/001F.

USEPA. 2005b. Ecological Soil Screening Levels for Antimony. Interim Final. OSWER Directive 9285.7-61, Revised. Office of Solid Waste and Emergency Response. February.

USEPA. 2005c. Ecological Soil Screening Levels for Arsenic. Interim Final. OSWER Directive 9285.7-61, Revised. Office of Solid Waste and Emergency Response. March.

USEPA. 2005d. Ecological Soil Screening Levels for Barium. Interim Final. OSWER Directive 9285.7-63, Revised. Office of Solid Waste and Emergency Response. February.

USEPA. 2005e. Ecological Soil Screening Levels for Cadmium. Interim Final. OSWER Directive 92857-65, Revised. Office of Solid Waste and Emergency Response. March.

USEPA. 2005f. Ecological Soil Screening Levels for Cobalt. Interim Final. OSWER Directive 92857-67, Revised. Office of Solid Waste and Emergency Response. March.

USEPA. 2005g. Ecological Soil Screening Levels for Vanadium. Interim Final. OSWER Directive 92857-70, Revised. Office of Solid Waste and Emergency Response. April.

USEPA. 2006a. Ecological Soil Screening Levels for Silver. Interim Final. OSWER Directive 92857-77, Revised. Office of Solid Waste and Emergency Response. September.

USEPA. 2006b. Region 3 BTAG freshwater sediment screening benchmarks. http://www.epa.gov/risk/freshwater-sediment-screening-benchmarks

USEPA. 2007a. Aquatic Life Ambient Freshwater Quality Criteria – Copper. 2007 Revision. EPA-822-R-07-001. February.

USEPA. 2007b. Ecological Soil Screening Levels (EcoSSLs) available at http://www.epa.gov/ecotox/ecossl/pdf/ecossl_attachment_4-1.pdf

USEPA. 2007c. Ecological Soil Screening Levels for Copper. Interim Final. OSWER Directive 92857-68, Revised. Office of Solid Waste and Emergency Response. February.

USEPA. 2007d. Ecological Soil Screening Levels for Manganese. Interim Final. OSWER Directive 92857-56, Revised. Office of Solid Waste and Emergency Response. April.

USEPA. 2007e. Ecological Soil Screening Levels for Nickel. Interim Final. OSWER Directive 92857-76, Revised. Office of Solid Waste and Emergency Response. March.

USEPA. 2007f. Ecological Soil Screening Levels for Selenium. Interim Final. OSWER Directive 92857-72, Revised. Office of Solid Waste and Emergency Response. July.

USEPA. 2007g. Ecological Soil Screening Levels for Zinc. Interim Final. OSWER Directive 92857-73, Revised. Office of Solid Waste and Emergency Response. June.

USEPA. 2008a. Child-Specific Exposure Factors Handbook (Final Report). U.S. Environmental Protection Agency, Washington, D.C., EPA/600/R-06/096F.

USEPA. 2008b. Ecological Soil Screening Levels for Chromium. Interim Final. OSWER Directive 9285.7-66, Revised. Office of Solid Waste and Emergency Response. April.

USEPA. 2008c. Recommended Toxicity Value for Uranium, Noncancer Endpoint for the Eastern Michaud Flats Site. July 10.

USEPA. 2009a. Administrative Settlement Agreement and Order on Consent/Consent Order for Remedial Investigation/Feasibility Study.

USEPA. 2009b. Risk Assessment Guidance for Superfund (RAGS). Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment). January.

USEPA. 2011. Exposure Factors Handbook 2011 Edition (Final). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-09/052F, 2011.

USEPA 2012. Compilation and Review of Data on Relative Bioavailability of Arsenic in Soil. OSWER 9200.1-113. December.

USEPA. 2013. ProUCL Version 5.0.00 Software. http://www.epa.gov/land-research/proucl-software

USEPA. 2015a. Regional Screening Levels for Chemical Contaminants at Superfund Sites. Last updated November 2015. http://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-november-2015

USEPA. 2015b. National Recommended Water Quality Criteria. Searched June 2015. http://www.epa.gov/wqc/national-recommended-water-quality-criteria

USEPA. 2015c. USEPA Ecotox Database available at http://cfpub.epa.gov/ecotox/help.cfm?help_id=SPECIESSEARCH&help_type=define&help_back=1

USEPA. 2015d. Preliminary Remediation Goals for Radionuclides. http://epa-prgs.ornl.gov/cgi-bin/radionuclides/rprg_search Accessed October, 2015.

USEPA. 2016a. National Recommended Water Quality Criteria. http://www.epa.gov/wqc/national-recommended-water-quality-criteria

USEPA. 2016b. National Primary Drinking Water Regulations. Accessed January. http://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants

USEPA. 2016c. Aquatic Life Ambient Water Quality Criterion for Selenium in Freshwater 2016. EPA 822-R-16-006. June.

USEPA. 2016d. Recommendations for Sieving Soil and Dust Samples at Lead Sites for Assessment of Incidental Ingestion. OLEM Directive 9200.1-128. July.

Woodruff, R.A., and B.L. Keller. 1982. Dispersal, Daily Activity, and Home Range of Coyotes in Southeastern Idaho. Northwest Science. Volume 56. Pages 199 through 207.

Zeiner, D.C., W.F. Laudenslayer, Jr., K.E. Mayer, and M. White, eds. 1988-1990. Maintained by California Wildlife Habitat Relationship Program of the California Department of Fish and Wildlife. Accessed at http://www.dfg.ca.gov/biogeodata/CWHR/cawildlife.aspx.

TABLES

TABLES

SECTION 2

Table A2-1
Data Summary for Metals in Upland Soil
Henry Site

Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detection Limit for Non-detects (mg/kg)	Minimum Detection Limit for Non-detects (mg/kg)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Mean Detected Concentration (mg/kg)	Standard Deviation for Detected Results (mg/kg)
Antimony	60	55	92	0.379	0.351	9.15	0.685	4.66	2.13
Arsenic	60	60	100	NA	NA	45.5	4.00	22.6	10.5
Boron	60	48	80	9.54	1.88	39.0	1.99	16.0	8.29
Cadmium	60	60	100	NA	NA	59.5	2.13	29.6	13.5
Chromium, Hexavalent	60	0	0	1.00	0.243	NA	NA	NA	NA
Chromium, Total [a]	60	60	100	NA	NA	519	19.9	242	137
Cobalt	60	60	100	NA	NA	11.9	2.98	7.29	2.12
Copper	60	60	100	NA	NA	172	11.1	98.7	44.5
Manganese	60	60	100	NA	NA	2,040	68.8	433	400
Mercury	60	60	100	NA	NA	0.503	0.0221	0.310	0.152
Molybdenum	60	56	93	1.14	1.05	35.7	1.41	15.8	8.77
Nickel	60	60	100	NA	NA	425	22.5	191	94.1
Radium-226 [b]	124,686	124,686	100	NA	NA	58.8	NA	12.5	3.70
Radon-222 [c]	15	15	100	NA	NA	13,327	2,941	6,410	2,879
Selenium	77	76	99	0.500	0.500	318	0.687	34.9	41.7
Silver	60	59	98	0.249	0.249	7.30	0.224	3.35	1.80
Thallium	60	60	100	NA	NA	2.31	0.171	1.20	0.497
Uranium	60	60	100	NA	NA	74.4	1.64	32.5	14.2
Vanadium	60	60	100	NA	NA	584	22.3	188	113
Zinc	60	60	100	NA	NA	1,610	121	812	360

Notes:

All concentrations in mg/kg except for radium-226, which is in picoCuries per gram (pCi/g) and radon-222, which is in picoCuries per cubic meter (pCi/m^3)

% - percent
mg/kg - milligram per kilogram
NA - not applicable

[a] Upland soil samples were analyzed for total unspeciated and hexavalent chromium. Hexavalent chromium was not detected in any sample; therefore, in remaining tables in this Baseline Risk Assessment, unspeciated chromium will be referred to as simply "chromium."

[b] Radium-226 concentrations were calculated from gamma count measurements as described in the On-Site and Background Areas Radiological and Soil Investigation Summary Report (MWH, 2015).

[c] Radon-222 concentrations were calculated from radon flux data as described in the On-Site and Background Areas Radiological and Soil Investigation Summary Report (MWH, 2015).

Table A2-2 Data Summary for Metals in Upland Vegetation Henry Site									
Plant Type Constituent	**Number of Samples**	**Number of Detections**	**Detection Frequency (%)**	**Maximum Detection Limit for Non-detects (mg/kg)**	**Minimum Detection Limit for Non-detects (mg/kg)**	**Maximum Detected Concentration (mg/kg)**	**Minimum Detected Concentration (mg/kg)**	**Mean Detected Concentration (mg/kg)**	**Standard Deviation for Detected Results (mg/kg)**
Non-Culturally Significant Plants									
Antimony	80	1	1	1.79	0.470	0.518	0.518	0.518	NA
Arsenic	80	65	81	0.0750	0.0696	10.2	0.0730	0.870	2.18
Boron	80	76	95	2.46	2.35	47.3	2.50	13.1	10.2
Cadmium	81	81	100	NA	NA	5.29	0.254	1.40	1.00
Chromium	80	80	100	NA	NA	18.2	1.38	2.94	2.15
Cobalt	80	6	8	0.623	0.115	0.298	0.126	0.188	0.0617
Copper	81	81	100	NA	NA	15.4	3.24	6.75	2.17
Manganese	80	80	100	NA	NA	54.8	8.99	26.5	10.6
Mercury	80	23	29	0.0493	0.00756	0.0687	0.00761	0.0192	0.0154
Molybdenum	81	80	99	1.46	1.46	125	1.53	16.7	22.6
Nickel	80	80	100	NA	NA	17.4	0.705	4.20	2.82
Selenium	138	91	66	0.600	0.500	146	0.451	12.1	28.1
Silver	80	5	6	0.0890	0.0459	0.164	0.0546	0.0937	0.0414
Thallium	80	79	99	0.0100	0.0100	0.713	0.0130	0.187	0.133
Uranium	80	7	9	0.178	0.0917	1.27	0.157	0.373	0.402
Vanadium	80	79	99	0.618	0.618	13.1	0.269	0.937	1.49
Zinc	81	81	100	NA	NA	109	17.3	50.0	17.4
Culturally Significant Plants [a]									
Antimony	5	0	0	0.500	0.496	NA	NA	NA	NA
Arsenic	5	2	40	0.370	0.0740	0.135	0.111	0.123	0.0170
Boron	5	5	100	NA	NA	42.2	13.2	25.8	11.4
Cadmium	5	5	100	NA	NA	5.56	0.132	2.48	2.71
Chromium	5	5	100	NA	NA	2.81	1.49	1.95	0.544
Cobalt	5	1	20	0.616	0.122	0.502	0.502	0.502	NA
Copper	5	5	100	NA	NA	7.20	3.66	5.88	1.42
Manganese	5	5	100	NA	NA	70.1	20.7	43.3	21.8
Mercury	5	1	20	0.00986	0.00978	0.0392	0.0392	0.0392	NA
Molybdenum	5	1	20	1.50	1.49	2.78	2.78	2.78	NA
Nickel	5	3	60	0.986	0.986	4.58	1.06	2.35	1.94
Selenium	5	5	100	NA	NA	5.26	0.504	1.88	1.95

Table A2-2
Data Summary for Metals in Upland Vegetation
Henry Site

Plant Type Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detection Limit for Non-detects (mg/kg)	Minimum Detection Limit for Non-detects (mg/kg)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Mean Detected Concentration (mg/kg)	Standard Deviation for Detected Results (mg/kg)
Silver	5	0	0	0.0493	0.0489	NA	NA	NA	NA
Thallium	5	0	0	0.00986	0.00978	NA	NA	NA	NA
Uranium	5	0	0	0.0986	0.0978	NA	NA	NA	NA
Vanadium	5	3	60	0.616	0.616	1.09	0.454	0.767	0.318
Zinc	5	5	100	NA	NA	231	12.8	80.0	90.1
All Plants									
Antimony	85	1	1	1.79	0.470	0.518	0.518	0.518	NA
Arsenic	85	67	79	0.370	0.0696	10.2	0.0730	0.848	2.15
Boron	85	81	95	2.46	2.35	47.3	2.50	13.9	10.7
Cadmium	86	86	100	NA	NA	5.56	0.132	1.46	1.16
Chromium	85	85	100	NA	NA	18.2	1.38	2.88	2.10
Cobalt	85	7	8	0.623	0.115	0.502	0.126	0.233	0.131
Copper	86	86	100	NA	NA	15.4	3.24	6.70	2.13
Manganese	85	85	100	NA	NA	70.1	8.99	27.5	12.0
Mercury	85	24	28	0.0493	0.00756	0.0687	0.00761	0.0200	0.0156
Molybdenum	86	81	94	1.50	1.46	125	1.53	16.5	22.5
Nickel	85	83	98	0.986	0.986	17.4	0.705	4.14	2.81
Selenium	143	96	67	0.600	0.500	146	0.451	11.6	27.5
Silver	85	5	6	0.0890	0.0459	0.164	0.0546	0.0937	0.0414
Thallium	85	79	93	0.0100	0.00978	0.713	0.0130	0.187	0.133
Uranium	85	7	8	0.178	0.0917	1.27	0.157	0.373	0.402
Vanadium	85	82	96	0.618	0.616	13.1	0.269	0.931	1.46
Zinc	86	86	100	NA	NA	231	12.8	51.7	26.8

Notes:

% - percent
mg/kg - milligram per kilogram
NA - not applicable

[a] The culturally significant species sampled include: big sagebrush (*Artemisia tridentata*), mountain strawberry (*Symphoricarpos oreophilus*), Rocky Mountain juniper (*Juniperus scopulorum*), quaking aspen (*Populus tremuloides*), and white sagebrush (*Artemisia ludoviciana*).

Table A2-3
Data Summary for Metals in Riparian Soil
Henry Site

Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detection Limit for Non-detects (mg/kg)	Minimum Detection Limit for Non-detects (mg/kg)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Mean Detected Concentration (mg/kg)	Standard Deviation for Detected Results (mg/kg)
Antimony	6	5	83	3.00	3.00	7.00	4.50	5.44	1.02
Arsenic	6	6	100	NA	NA	4.99	1.12	2.97	1.56
Boron	6	6	100	NA	NA	5.90	3.50	5.08	0.873
Cadmium	34	34	100	NA	NA	67.3	0.392	5.34	11.8
Chromium	34	34	100	NA	NA	467	14.4	55.9	90.1
Cobalt	6	6	100	NA	NA	8.73	4.25	6.44	1.87
Copper	34	34	100	NA	NA	56.0	5.80	19.0	9.94
Manganese	6	6	100	NA	NA	1,080	145	583	387
Mercury	6	6	100	NA	NA	0.0240	0.0120	0.0195	0.00485
Molybdenum	34	27	79	0.500	0.0500	14.8	0.287	1.92	3.11
Nickel	34	34	100	NA	NA	251	10.3	35.6	46.5
Selenium	34	28	82	0.500	0.500	45.0	0.700	5.73	10.2
Silver	6	6	100	NA	NA	0.125	0.0980	0.108	0.0119
Thallium	6	6	100	NA	NA	0.223	0.105	0.162	0.0471
Uranium	6	6	100	NA	NA	1.66	0.748	1.16	0.334
Vanadium	34	34	100	NA	NA	773	14.7	67.2	131
Zinc	34	34	100	NA	NA	1,600	49.7	189	278

Notes:

% - percent
mg/kg - milligram per kilogram
NA - not applicable

Table A2-4
Data Summary for Metals in Riparian Vegetation
Henry Site

Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detection Limit for Non-detects (mg/kg)	Minimum Detection Limit for Non-detects (mg/kg)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Mean Detected Concentration (mg/kg)	Standard Deviation for Detected (mg/kg)
Cadmium	28	21	75	0.050	0.05	2.87	0.0500	0.626	0.701
Copper	28	28	100	NA	NA	7.70	1.90	4.45	1.48
Molybdenum	28	28	100	NA	NA	19.3	0.400	2.41	3.55
Selenium	28	7	25	0.500	0.50	65.0	0.500	15.6	23.4
Zinc	28	28	100	NA	NA	335	11.0	46.2	60.0

Notes:

% - percent
mg/kg - milligram per kilogram
NA - not applicable

Table A2-5
Data Summary for Metals in Surface Water
Henry Site

Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detection Limit for Non-detects (mg/L)	Minimum Detection Limit for Non-detects (mg/L)	Maximum Detected Concentration (mg/L)	Minimum Detected Concentration (mg/L)	Mean Detected Concentration (mg/L)	Standard Deviation for Detected Results (mg/L)
Aluminum, Dissolved, all locations	33	8	24	0.0500	0.0300	0.905	0.0300	0.319	0.361
Upstream	10	1	10	0.0500	0.0300	0.0300	0.0300	0.0300	NA
Downstream	17	5	29	0.0500	0.0300	0.844	0.0400	0.315	0.319
Pond	6	2	33	0.0300	0.0300	0.905	0.0400	0.473	0.612
Antimony, Dissolved, all locations	30	5	17	0.00300	0.000400	0.00230	0.000400	0.000920	0.000785
Upstream	8	3	38	0.000400	0.000400	0.00230	0.000400	0.00110	0.00104
Downstream	14	0	0	0.00300	0.000400	NA	NA	NA	NA
Pond	8	2	25	0.00300	0.000400	0.000800	0.000500	0.000650	0.000212
Arsenic, Dissolved, all locations	30	16	53	0.000500	0.000500	0.0224	0.000530	0.00490	0.00707
Upstream	8	5	63	0.000500	0.000500	0.00790	0.000600	0.00240	0.00309
Downstream	14	6	43	0.000500	0.000500	0.0224	0.000530	0.00745	0.0105
Pond	8	5	63	0.000500	0.000500	0.0129	0.00117	0.00433	0.00483
Barium, Dissolved, all locations	24	24	100	NA	NA	0.0810	0.00600	0.0441	0.0193
Upstream	8	8	100	NA	NA	0.0710	0.0240	0.0443	0.0153
Downstream	11	11	100	NA	NA	0.0810	0.0240	0.0536	0.0168
Pond	5	5	100	NA	NA	0.0380	0.00600	0.0229	0.0149
Beryllium, Dissolved, all locations	24	0	0	0.00200	0.00200	NA	NA	NA	NA
Upstream	8	0	0	0.00200	0.00200	NA	NA	NA	NA
Downstream	11	0	0	0.00200	0.00200	NA	NA	NA	NA
Pond	5	0	0	0.00200	0.00200	NA	NA	NA	NA
Boron, Dissolved, all locations	12	9	75	0.0100	0.00200	0.121	0.0100	0.0422	0.0443
Upstream	3	3	100	NA	NA	0.0200	0.0100	0.0133	0.00577
Downstream	5	4	80	0.0100	0.0100	0.121	0.0146	0.0679	0.0585
Pond	4	2	50	0.0100	0.00200	0.0402	0.0280	0.0341	0.00863

Table A2-5
Data Summary for Metals in Surface Water
Henry Site

Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detection Limit for Non-detects (mg/L)	Minimum Detection Limit for Non-detects (mg/L)	Maximum Detected Concentration (mg/L)	Minimum Detected Concentration (mg/L)	Mean Detected Concentration (mg/L)	Standard Deviation for Detected Results (mg/L)
Cadmium, dissolved, all locations	125	20	16	0.000600	0.000100	0.0352	0.0000120	0.00591	0.0109
Upstream	28	7	25	0.000300	0.000100	0.00780	0.000129	0.00191	0.00289
Downstream	83	3	4	0.000600	0.000100	0.000166	0.0000120	0.000101	0.0000799
Pond	14	10	71	0.000125	0.000100	0.0352	0.0000180	0.0105	0.0141
Calcium, dissolved, all locations	125	125	100	NA	NA	281	5.80	86.0	43.5
Upstream	28	28	100	NA	NA	281	34.2	114	52.4
Downstream	83	83	100	NA	NA	142	5.80	68.9	25.9
Pond	14	14	100	NA	NA	232	64.3	131	48.5
Chromium, dissolved, all locations	71	37	52	0.000500	0.000100	0.00760	0.000200	0.00142	0.00193
Upstream	17	8	47	0.000500	0.000100	0.00260	0.000200	0.000641	0.000807
Downstream	44	19	43	0.000500	0.000100	0.00343	0.000200	0.00110	0.00110
Pond	10	10	100	NA	NA	0.00760	0.000300	0.00266	0.00309
Cobalt, Dissolved, all locations	30	6	20	0.0100	0.0100	0.0141	0.000964	0.00603	0.00595
Upstream	8	0	0	0.0100	0.0100	NA	NA	NA	NA
Downstream	14	3	21	0.0100	0.0100	0.0141	0.000964	0.00942	0.00734
Pond	8	3	38	0.0100	0.0100	0.00303	0.00218	0.00264	0.000429
Copper, Dissolved, all locations	30	6	20	0.0100	0.0100	0.00379	0.000550	0.00171	0.00133
Upstream	8	0	0	0.0100	0.0100	NA	NA	NA	NA
Downstream	14	3	21	0.0100	0.0100	0.00379	0.000550	0.00236	0.00165
Pond	8	3	38	0.0100	0.0100	0.00177	0.000680	0.00105	0.000624
Iron, dissolved, all locations	46	13	28	0.0250	0.0200	0.877	0.0200	0.183	0.301
Upstream	12	1	8	0.0250	0.0200	0.160	0.160	0.160	NA
Downstream	28	11	39	0.0250	0.0200	0.827	0.0200	0.122	0.238
Pond	6	1	17	0.0200	0.0200	0.877	0.877	0.877	NA

Table A2-5
Data Summary for Metals in Surface Water
Henry Site

Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detection Limit for Non-detects (mg/L)	Minimum Detection Limit for Non-detects (mg/L)	Maximum Detected Concentration (mg/L)	Minimum Detected Concentration (mg/L)	Mean Detected Concentration (mg/L)	Standard Deviation for Detected Results (mg/L)
Lead, Dissolved, all locations	24	3	13	0.000100	0.000100	0.000430	0.000400	0.000410	0.0000173
Upstream	8	1	13	0.000100	0.000100	0.000430	0.000430	0.000430	NA
Downstream	11	2	18	0.000100	0.000100	0.000400	0.000400	0.000400	0
Pond	5	0	0	0.000100	0.000100	NA	NA	NA	NA
Magnesium, dissolved, all locations	125	125	100	NA	NA	62.6	1.10	24.2	14.3
Upstream	28	28	100	NA	NA	58.2	7.80	30.4	15.6
Downstream	83	83	100	NA	NA	49.2	1.10	19.0	10.4
Pond	14	14	100	NA	NA	62.6	23.2	42.4	12.8
Manganese, dissolved, all locations	39	37	95	0.000500	0.000500	2.44	0.00120	0.241	0.601
Upstream	10	10	100	NA	NA	0.538	0.00710	0.152	0.166
Downstream	20	20	100	NA	NA	2.33	0.00120	0.213	0.630
Pond	9	7	78	0.000500	0.000500	2.44	0.00600	0.446	0.896
Mercury, Dissolved, all locations	30	0	0	0.000200	0.0000200	NA	NA	NA	NA
Upstream	8	0	0	0.000200	0.000200	NA	NA	NA	NA
Downstream	14	0	0	0.000200	0.0000200	NA	NA	NA	NA
Pond	8	0	0	0.000200	0.0000200	NA	NA	NA	NA
Molybdenum, Dissolved, all locatio	30	8	27	0.0100	0.000600	0.0400	0.00370	0.0190	0.0136
Upstream	8	1	13	0.0100	0.0100	0.0300	0.0300	0.0300	NA
Downstream	14	2	14	0.0100	0.000600	0.0192	0.0191	0.0192	0.0000707
Pond	8	5	63	0.0100	0.0100	0.0400	0.00370	0.0168	0.0170
Nickel, dissolved, all locations	88	81	92	0.00100	0.000200	1.26	0.000300	0.0374	0.162
Upstream	19	19	100	NA	NA	0.0646	0.000630	0.00944	0.0141
Downstream	55	48	87	0.00100	0.000200	0.0265	0.000300	0.00334	0.00548
Pond	14	14	100	NA	NA	1.26	0.00350	0.192	0.361

Table A2-5
Data Summary for Metals in Surface Water
Henry Site

Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detection Limit for Non-detects (mg/L)	Minimum Detection Limit for Non-detects (mg/L)	Maximum Detected Concentration (mg/L)	Minimum Detected Concentration (mg/L)	Mean Detected Concentration (mg/L)	Standard Deviation for Detected Results (mg/L)
Potassium, dissolved, all locations	83	82	99	0.300	0.300	102	0.400	3.32	11.3
Upstream	20	20	100	NA	NA	5.10	0.730	1.69	1.02
Downstream	52	51	98	0.300	0.300	102	0.400	4.16	14.3
Pond	11	11	100	NA	NA	9.30	0.600	2.41	2.57
Selenium, total, all locations	126	86	68	0.00500	0.000500	0.970	0.000585	0.0515	0.142
Upstream	29	22	76	0.00100	0.00100	0.290	0.00100	0.0347	0.0668
Downstream	83	50	60	0.00500	0.000500	0.0460	0.000585	0.00494	0.00788
Pond	14	14	100	NA	NA	0.970	0.00530	0.244	0.276
Silver, Dissolved, all locations	30	0	0	0.0100	0.00000400	NA	NA	NA	NA
Upstream	8	0	0	0.0100	0.0100	NA	NA	NA	NA
Downstream	14	0	0	0.0100	0.00000400	NA	NA	NA	NA
Pond	8	0	0	0.0100	0.00000400	NA	NA	NA	NA
Sodium, dissolved, all locations	83	83	100	NA	NA	68.6	1.40	14.6	15.9
Upstream	20	20	100	NA	NA	19.0	3.80	10.1	4.52
Downstream	52	52	100	NA	NA	68.6	2.30	18.1	19.0
Pond	11	11	100	NA	NA	10.5	1.40	6.39	3.15
Thallium, Dissolved, all locations	30	5	17	0.000100	0.00000200	0.000348	0.0000590	0.000174	0.000119
Upstream	8	0	0	0.000100	0.000100	NA	NA	NA	NA
Downstream	14	2	14	0.000100	0.00000200	0.000348	0.0000590	0.000204	0.000204
Pond	8	3	38	0.000100	0.00000200	0.000200	0.0000640	0.000155	0.0000785
Uranium, dissolved, all locations	52	49	94	0.000100	0.000100	0.0206	0.000700	0.00356	0.00418
Upstream	13	12	92	0.000100	0.000100	0.0134	0.000700	0.00696	0.00499
Downstream	30	28	93	0.000100	0.000100	0.0206	0.000700	0.00240	0.00366
Pond	9	9	100	NA	NA	0.00493	0.00110	0.00266	0.00161

Table A2-5
Data Summary for Metals in Surface Water
Henry Site

Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detection Limit for Non-detects (mg/L)	Minimum Detection Limit for Non-detects (mg/L)	Maximum Detected Concentration (mg/L)	Minimum Detected Concentration (mg/L)	Mean Detected Concentration (mg/L)	Standard Deviation for Detected Results (mg/L)
Vanadium, dissolved, all locations	123	72	59	0.0250	0.0000500	0.0885	0.000400	0.00742	0.0164
Upstream	26	11	42	0.00500	0.0000500	0.0402	0.000400	0.00666	0.0115
Downstream	83	48	58	0.0250	0.000200	0.0885	0.000400	0.00539	0.0156
Pond	14	13	93	0.00500	0.00500	0.0689	0.00185	0.0155	0.0210
Zinc, dissolved, all locations	88	58	66	0.0100	0.00200	4.73	0.000800	0.156	0.699
Upstream	19	14	74	0.00500	0.00200	0.142	0.00200	0.0190	0.0367
Downstream	55	33	60	0.0100	0.00200	0.110	0.000800	0.00848	0.0185
Pond	14	11	79	0.0100	0.00200	4.73	0.000800	0.772	1.50

Notes:

% - percent
mg/L - milligram per liter
NA - not applicable

Table A2-6
Data Summary for Metals in Sediment
Henry Site

Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detection Limit for Non-detects (mg/kg)	Minimum Detection Limit for Non-detects (mg/kg)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Mean Detected Concentration (mg/kg)	Standard Deviation for Detected (mg/kg)
Antimony	18	13	72	3.00	3.00	8.50	3.60	6.06	1.629
Arsenic	18	18	100	NA	NA	10.6	1.53	6.42	2.60
Boron	18	18	100	NA	NA	17.4	4.40	8.38	3.88
Cadmium	39	39	100	NA	NA	104	0.481	13.2	19.9
Chromium	39	39	100	NA	NA	1,030	10.7	97.0	173
Cobalt	18	18	100	NA	NA	10.6	2.77	6.49	2.37
Copper	18	18	100	NA	NA	68.8	10.6	35.4	14.9
Manganese	18	18	100	NA	NA	2,580	119	766	676
Mercury	18	18	100	NA	NA	0.24	0.0200	0.0876	0.0556
Molybdenum	18	12	67	0.500	0.500	10.8	2.20	4.57	2.27
Nickel	40	40	100	NA	NA	1,110	8.60	78.8	174
Selenium	40	35	88	0.600	0.500	148	0.500	22.0	32.2
Silver	18	18	100	NA	NA	2.16	0.117	0.716	0.566
Thallium	18	18	100	NA	NA	2.17	0.121	0.879	0.575
Uranium	18	18	100	NA	NA	90.0	1.65	17.7	23.1
Vanadium	40	40	100	NA	NA	940	12.7	110	175
Zinc	40	40	100	NA	NA	7,940	42.0	519	1,257

Notes:

% - percent
mg/kg - milligram per kilogram
NA - not applicable

Table A2-7
Data Summary for Metals in Groundwater
Henry Site

Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detection Limit for Non-detects (mg/L)	Minimum Detection Limit for Non-detects (mg/L)	Maximum Detected Concentration (mg/L)	Minimum Detected Concentration (mg/L)	Mean Detected Concentration (mg/L)	Standard Deviation for Detected Results (mg/L)
Aluminum, total	29	7	24	0.0500	0.0300	0.322	0.0400	0.172	0.100
Antimony, total	12	3	25	0.00400	0.000250	0.00170	0.000400	0.000877	0.000716
Arsenic, total	12	7	58	0.000500	0.000250	0.00430	0.000500	0.00217	0.00183
Barium, total	12	11	92	0.00300	0.00300	0.288	0.0380	0.104	0.0800
Beryllium, Total	12	0	0	0.00200	0.000500	NA	NA	NA	NA
Boron, total	11	9	82	0.0100	0.0100	0.0400	0.0100	0.0256	0.0101
Cadmium, total	58	19	33	0.100	0.000100	0.00628	0.000100	0.00207	0.00214
Calcium, total	18	18	100	NA	NA	196	7.50	88.5	49.7
Chromium, total	26	16	62	0.100	0.000100	0.00380	0.000400	0.00207	0.000836
Cobalt, total	12	2	17	0.0100	0.000250	0.0100	0.0100	0.0100	0
Copper, total	12	1	8	0.0100	0.0100	0.0231	0.0231	0.0231	NA
Iron, total	31	25	81	0.0250	0.0200	8.06	0.0300	1.10	1.86
Iron III, total	2	2	100	NA	NA	0.700	0.320	0.510	0.269
Lead, total	12	7	58	0.000250	0.000100	0.000900	0.000100	0.000461	0.000312
Magnesium, total	18	18	100	NA	NA	54.4	11.9	26.6	10.0
Manganese, total	49	45	92	0.500	0.00200	3.39	0.000547	0.273	0.560
Mercury, total	12	0	0	0.000200	0.000100	NA	NA	NA	NA
Molybdenum, total	12	2	17	0.0100	0.00500	0.110	0.0300	0.0700	0.0566
Nickel, total	33	27	82	0.600	0.000600	0.171	0.000800	0.0261	0.0427
Potassium, total	18	18	100	NA	NA	5.90	0.800	2.32	1.42
Selenium, total	66	50	76	0.00100	0.000500	0.219	0.000563	0.0230	0.0440
Silver, total	12	0	0	0.0100	0.000250	NA	NA	NA	NA
Sodium, total	11	11	100	NA	NA	84.9	6.70	30.3	24.5
Thallium, total	12	6	50	0.000100	0.0000500	0.000900	0.000100	0.000567	0.000356
Uranium, total	12	11	92	0.000100	0.000100	0.0128	0.00110	0.00565	0.00502
Vanadium, total	33	11	33	0.200	0.000200	0.0125	0.000600	0.00468	0.00423
Zinc, total	33	27	82	0.00500	0.00200	1.56	0.00200	0.262	0.385

Notes:

% - percent NA - not applicable mg/L - milligram per liter

TABLES

SECTION 3

Table A3-1
Selection of Constituents of Potential Concern in Upland Soil
Henry Site

Analyte	Maximum Detected Concentration (mg/kg)	Residential USEPA Regional Screening Levels for Soil (mg/kg)	Carcinogen / Non-Carcinogen	Soil Screening Level [a] (mg/kg)	COPC based on Residential Screening Level (Yes/No)
Antimony	9.15	31	NC	3.1	**Yes**
Arsenic	45.5	0.68	C	0.68	**Yes**
Boron	39.0	16,000	NC	1,600	No
Cadmium	59.5	71	NC	7.1	**Yes**
Chromium [b]	519	120,000	NC	12,000	No
Cobalt	11.9	23	NC	2.3	**Yes**
Copper	172	3,100	NC	310	No [c]
Manganese	2,040	1,800	NC	180	**Yes**
Mercury	0.503	23.0	NC	2.3	No
Molybdenum	35.7	390	NC	39	No
Nickel	425	1,500	NC	150	**Yes**
Radium-226 [d]	58.8	0.00643	C	0.00643	**Yes**
Radon-222 [d]	13,327	0.194	C	0.194	**Yes**
Selenium	318	390	NC	39	**Yes**
Silver	7.30	390	NC	39	No [c]
Thallium	2.31	0.78	NC	0.078	**Yes**
Uranium	74.4	230	NC	23	**Yes**
Vanadium	584	390	NC	39	**Yes**
Zinc	1,610	23,000	NC	2,300	No [c]

Notes:

All concentrations in mg/kg except for radium-226, which is in picoCuries per gram (pCi/g) and radon-222, which is in picoCuries per cubic meter (pCi/m^3)

[a] The soil screening levels for chemicals are equal to the November 2015 USEPA Residential Soil Regional Screening Level (RSL) for carcinogens (equivalent to a cancer risk of one-in-a-million), or 1/10th the USEPA Residential Soil RSL for non-carcinogens (equivalent to a hazard quotient of 0.1), to account for potential cumulative effects of exposure to multiple contaminants (USEPA, 2015a).

[b] As noted in Table A2-1, hexavalent chromium was non-detect in all upland soil samples. The maximum concentration shown here is for total chromium; because screening values are not available for unspeciated chromium, the RSL in this table is for trivalent chromium.

[c] The USEPA (2000) has identified this analyte as a potentially bioaccumulative constituent. However, concentrations of this analyte in upland vegetation were much lower than concentrations detected in soil, and as a result, this analyte was not selected as a COPC based on the Tier II bioaccumulative screening as described in Section 3.1.

[d] The screening levels for radium-226 and radium-222 were calculated using the USEPA's Preliminary Remediation Goal (PRG) calculator as the default soil and ambient air PRGs, respectively, for a resident, calculated in the USEPA's online PRG calculator October, 2015. The PRG for radium-226 and radon-222 are for the primary radionuclide plus decay chain daughter products.

C - carcinogen
COPC - constituent of potential concern
mg/kg - milligrams per kilogram
NC - non-carcinogen
USEPA - United States Environmental Protection Agency

Table A3-2
Selection of Chemicals of Potential Concern in Riparian Soil
Henry Site

Analyte	Maximum Detected Concentration (mg/kg)	Residential USEPA Regional Screening Levels for Soil (mg/kg)	Carcinogen / Non-carcinogen	Soil Screening Level [a] (mg/kg)	COPC based on Residential Screening Level (Yes/No)
Antimony	7.00	31	NC	3.1	**Yes**
Arsenic	4.99	0.68	C	0.68	**Yes**
Boron	5.90	16,000	NC	1,600	No
Cadmium	67.3	71	NC	7.1	**Yes**
Chromium [b]	467	120,000	NC	12,000	No
Cobalt	8.73	23	NC	2.3	**Yes**
Copper	56.0	3,100	NC	310	No [c]
Manganese	1,080	1,800	NC	180	**Yes**
Mercury	0.0240	23.0	NC	2.3	No
Molybdenum	14.8	390	NC	39	No
Nickel	251	1,500	NC	150	**Yes**
Selenium	45.0	390	NC	39	**Yes**
Silver	0.125	390	NC	39	No [c]
Thallium	0.223	0.78	NC	0.078	**Yes**
Uranium	1.66	230	NC	23	No
Vanadium	773	390	NC	39	**Yes**
Zinc	1,600	23,000	NC	2,300	No [c]

Notes:

[a] The soil screening level is equal to the November 2015 USEPA Residential Soil Regional Screening Level (RSL) for carcinogens (equivalent to a cancer risk of one-in-a-million), or 1/10th the USEPA Residential Soil RSL for non-carcinogens (equivalent to a hazard quotient of 0.1), to account for potential cumulative effects of exposure to multiple contaminants (USEPA, 2015a).
[b] Measured as total chromium; however, because chromium VI was not detected in soil samples, total chromium is assumed to be represented by chromium III.
[c] The USEPA (2000) has identified this analyte as a potentially bioaccumulative constituent. However, concentrations of this analyte in riparian vegetation were much lower than concentrations detected in soil, and as a result, this analyte was not selected as a COPC based on the Tier II bioaccumulative screening as described in Section 3.1.

C - carcinogen
COPC - chemical of potential concern
mg/kg - milligrams per kilogram
NC - non-carcinogen
USEPA - United States Environmental Protection Agency

Table A3-3
Selection of Constituents of Potential Concern in Surface Water
Henry Site

Analyte	Maximum Detected Concentration (mg/L)	State of Idaho Standards Surface Water [1] (mg/L)	National Standards Aquatic Life [2] Organism Consumption W+O (mg/L)	National Standards Aquatic Life [2] Organism Consumption O Only (mg/L)	USEPA RSL [3] Tap Water (mg/L)	Comparison Values of Drinking Water [4] Child (mg/L)	Comparison Values of Drinking Water [4] Adult (mg/L)	USEPA MCL [5] Primary (mg/L)	USEPA MCL [5] Secondary (mg/L)	COPC Screening Criteria [6] (mg/L)	Surface Water COPC (Yes/No)
Aluminum, dissolved	0.905	- -	- -	- -	20	20	70	- -	0.05 to 0.2	20	No
Antimony, dissolved	0.00230	0.0056	0.0056	0.64	0.0078	0.0040	0.010	0.0060	- -	0.0056	No
Arsenic, dissolved	0.0224	0.010	0.000018	0.00014	0.000052	0.0030	0.010	0.010	- -	0.010	**Yes**
Barium, dissolved	0.0810	- -	1.0	- -	3.8	- -	- -	2.0	- -	1.0	No
Boron, dissolved	0.121	- -	- -	- -	4.0	0.10	0.40	- -	- -	4.0	No
Cadmium, dissolved	0.0352	- -	- -	- -	0.0092	0.0020	0.0070	0.005	- -	0.0092	**Yes**
Calcium, dissolved	281	- -	- -	- -	- -	- -	- -	- -	- -	- -	No [b]
Chromium, dissolved	0.00760	- -	- -	- -	22/0.000035 [a]	0.10	0.10	0.10	- -	0.000035	**Yes**
Cobalt, dissolved	0.0141	- -	- -	- -	0.0060	0.10	0.40	- -	- -	0.0060	**Yes**
Copper, dissolved	0.00379	- -	1.3	- -	0.80	0.10	0.40	1.3	1.0	1.3	No
Iron, dissolved	0.877	- -	0.3	- -	1.4	- -	- -	- -	0.3	0.3	No [b]
Lead, dissolved	0.000430	- -	- -	- -	0.015	- -	- -	0.015	- -	0.015	No
Magnesium, dissolved	62.6	- -	- -	- -	- -	- -	- -	- -	- -	- -	No [b]
Manganese, dissolved	2.4	- -	0.050	0.10	0.43	- -	- -	- -	0.05	0.050	**Yes**
Molybdenum, dissolved	0.0400	- -	- -	- -	0.10	0.050	0.20	- -	- -	0.10	No
Nickel, dissolved	1.26	0.61	0.61	4.6	0.39	0.20	0.70	- -	- -	0.61	**Yes**
Potassium, dissolved	102	- -	- -	- -	- -	- -	- -	- -	- -	- -	No [b]
Selenium, total	0.970	0.17	0.17	4.2	0.10	0.050	0.20	0.05	- -	0.17	**Yes**
Sodium, dissolved	68.6	- -	- -	- -	- -	- -	- -	- -	- -	- -	No [b]
Thallium, dissolved	0.000348	0.00024	0.00024	0.00047	0.00020	- -	- -	0.002	- -	0.00024	**Yes**
Uranium, dissolved	0.0206	- -	- -	- -	0.060	0.030	0.030	0.03	- -	0.060	No
Vanadium, dissolved	0.0885	- -	- -	- -	0.086	0.03	0.10	- -	- -	0.086	**Yes**
Zinc, dissolved	4.73	7.4	7.4	26	6.0	3.0	10	- -	5.0	7.4	No

Notes:

[1] State of Idaho Surface Water Quality for Domestic Water Supply Use (IDAPA 58.01.02) (IAC, 2009a).

[2] National Recommended Water Quality Criteria (USEPA, 2015b); Criteria for Human Health for Organism Consumption of Water + Organism (W+O) and Organism Only (O Only).

Table A3-3
Selection of Constituents of Potential Concern in Surface Water
Henry Site

Analyte	Maximum Detected Concentration (mg/L)	State of Idaho Standards Surface Water [1] (mg/L)	National Standards Aquatic Life [2] Organism Consumption W+O (mg/L)	National Standards Aquatic Life [2] Organism Consumption O Only (mg/L)	USEPA RSL [3] Tap Water (mg/L)	Comparison Values of Drinking Water [4] Child (mg/L)	Comparison Values of Drinking Water [4] Adult (mg/L)	USEPA MCL [5] Primary (mg/L)	USEPA MCL [5] Secondary (mg/L)	COPC Screening Criteria [6] (mg/L)	Surface Water COPC (Yes/No)

[3] USEPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites, equivalent to a cancer risk of one-in-a-million for carcinogens, or a hazard quotient of 1 for non-carcinogens (USEPA, 2015a).

[4] Public Health Assessment: Southeast Idaho Phosphate Mining Resource Area: Bannock, Bear Lake, Bingham, and Caribou Counties, Idaho EPA Facility ID: IDN001002245 (U.S. Department of Health and Human Services, Public Health Services, Agency for Toxic Substances and Disease Registry [ATSDR], 2006).

[5] USEPA primary and secondary Maximum Contaminant Level (MCL), National Primary Drinking Water Regulations (USEPA, 2016).

[6] Proposed COPC screening criteria is based on the following hierarchy:

1) State of Idaho Surface Water Quality for Domestic Water Supply Use (IDAPA 58.01.02) (IAC, 2009a).
2) National Recommended Water Quality Criteria (USEPA, 2016a); Criteria for Human Health for Organism Consumption of Water + Organism (W+O) and Organism Only (O Only).
3) USEPA RSLs for Chemical Contaminants at Superfund Sites (USEPA, 2015a).
4) Public Health Assessment: Southeast Idaho Phosphate Mining Resource Area (ATSDR, 2006).
5) USEPA primary and secondary MCLs, National Primary Drinking Water Regulations (USEPA, 2016b).

[a] Values specified are for chromium III/VI. Consistent with the Agencies and Tribes-approved Remedial Investigation and Feasibility Study Work Plan for the P4 Sites (MWH, 2011), the total chromium results are compared to the hexavalent chromium standard.

[b] The analyte was not selected as a COPC because it is a naturally occuring essential nutrient with low toxicity

"- -" - not available
COPC - constituent of potential concern
IDAPA - Idaho Administrative Procedures Act
mg/L - milligrams per liter
USEPA - United States Environmental Protection Agency

Table A3-4
Selection of Chemicals of Potential Concern in Sediment
Henry Site

Analyte	Maximum Detected Concentration (mg/kg)	Residential USEPA Regional Screening Levels for Soil (mg/kg)	Carcinogen / Non-Carcinogen	Sediment Screening Level [a] (mg/kg)	COPC based on Residential Screening Level (Yes/No)
Antimony	8.50	31	NC	3.1	**Yes**
Arsenic	10.6	0.68	C	0.68	**Yes**
Boron	17.4	16,000	NC	1,600	No
Cadmium	104	71	NC	7.1	**Yes**
Chromium	1,030	120,000	NC	12,000	No
Cobalt	10.6	23	NC	2.3	**Yes**
Copper	68.8	3,100	NC	310	No
Manganese	2,580	1,800	NC	180	**Yes**
Mercury	0.236	23.0	NC	2.3	No
Molybdenum	10.8	390	NC	39	No
Nickel	1,110	1,500	NC	150	**Yes**
Selenium	148	390	NC	39	**Yes**
Silver	2.16	390	NC	39	No
Thallium	2.17	0.78	NC	0.078	**Yes**
Uranium	90.0	230	NC	23	**Yes**
Vanadium	940	390	NC	39	**Yes**
Zinc	7,940	23,000	NC	2,300	**Yes**

Notes:

[a] The sediment screening level is equal to the November 2015 USEPA Residential Soil Regional Screening Level (RSL) for carcinogens (equivalent to a cancer risk of one-in-a-million), or 1/10th the USEPA Residential Soil RSL for non-carcinogens (equivalent to a hazard quotient of 0.1), to account for potential cumulative effects of exposure to multiple contaminants (USEPA, 2015a).

C - carcinogen
COPC - chemical of potential concern
mg/kg - milligrams per kilogram
NC - non-carcinogen
USEPA - United States Environmental Protection Agency

Table A3-5
Selection of Constituents of Potential Concern in Groundwater
Henry Site

Analyte	Maximum Detected Concentration (mg/L)	USEPA RSL [1] Tap Water (mg/L)	IDEQ Area-Wide RMP [2] Groundwater Levels		State of Idaho Standards Ground Water [5] (mg/L)	USEPA MCL [6]		Health Comparison Values of Drinking Water [7]		Groundwater COPC Screening Criteria [8] (mg/L)	Groundwater Preliminary COPC (Yes/No)
			Remedial A[3] (mg/L)	Monitoring [4] (mg/L)		Primary (mg/L)	Secondary (mg/L)	Child (mg/L)	Adult (mg/L)		
Aluminum, total	0.322	20	- -	- -	0.2[a]	- -	0.2	20	70	20	No
Antimony, total	0.00170	0.0078	- -	- -	0.006	0.006	- -	0.0040	0.010	0.0078	No
Arsenic, total	0.00430	0.000052	- -	- -	0.05	0.01	- -	0.0030	0.010	0.000052	**Yes**
Barium, total	0.288	3.8	- -	- -	2	2	- -	- -	- -	3.8	No
Boron, total	0.0400	4.0	- -	- -	- -	- -	- -	0.10	0.40	4.0	No
Cadmium, total	0.00628	0.0092	0.005[b]	0.0010	0.005	0.005	- -	0.0020	0.0070	0.0092	No
Calcium, total	196	- -	- -	- -	- -	- -	- -	- -	- -	- -	No [f]
Chromium, total	0.00380	22/0.000035 [c]	0.1[b]	0.025[d]	0.1	0.1	- -	0.1	0.100	0.000035	**Yes**
Cobalt, total	0.0100	0.00600	- -	- -	- -	- -	- -	0.10	0.40	0.0060	**Yes**
Copper, total	0.0231	0.80	1.3[b]	0.011	1.3	1.3	1	0.10	0.40	0.80	No
Iron, total	8.06	14	- -	- -	0.3[a]	- -	0.3	- -	- -	14	No [f]
Lead, total	0.000900	0.015	- -	- -	0.015	0.015	- -	- -	- -	0.015	No
Magnesium, total	54.4	- -	- -	- -	- -	- -	- -	- -	- -	- -	No [f]
Manganese, total	3.39	0.43	- -	- -	0.05	- -	0.05	- -	- -	0.43	**Yes**
Molybdenum, total	0.1100	0.10	- -	- -	- -	- -	- -	0.050	0.20	0.10	**Yes**
Nickel, total	0.171	0.39	0.73	0.160	- -	- -	- -	0.20	0.70	0.39	No
Potassium, total	5.90	- -	- -	- -	- -	- -	- -	- -	- -	- -	No [f]
Selenium, total	0.219	0.010	0.05[b]	0.0050	0.05	0.05	- -	0.050	0.20	0.010	**Yes**
Sodium, total	84.9	- -	- -	- -	- -	- -	- -	- -	- -	- -	No [f]
Thallium, total	0.000900	0.00020	- -	- -	0.002	0.002	- -	- -	- -	0.00020	**Yes**
Uranium, total	0.0128	0.060	- -	- -	- -	0.03	- -	0.030	0.030	0.060	No
Vanadium, total	0.0125	0.086	0.26	0.02[e]	- -	- -	- -	0.030	0.10	0.086	No
Zinc, total	1.56	6.0	5[b]	0.100	5[a]	- -	5	3.0	10	6.0	No

Notes:

[1] United States Environmental Protection Agency (USEPA) Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites equivalent to a cancer risk of one-in-a-million for carcinogens, or a hazard quotient of 1 for non-carcinogens (USEPA 2015a).

[2] Remedial action and monitoring levels; Area-Wide Risk Management Plan (RMP [IDEQ, 2004b]).

[3] Remedial action levels for total recoverable groundwater, as presented in the RMP (IDEQ, 2004b).

Table A3-5
Selection of Constituents of Potential Concern in Groundwater
Henry Site

Analyte	Maximum Detected Concentration (mg/L)	USEPA RSL [1] Tap Water (mg/L)	IDEQ Area-Wide RMP [2] Groundwater Levels		State of Idaho Standards Ground Water [5] (mg/L)	USEPA MCL [6]		Health Comparison Values of Drinking Water [7]		Groundwater COPC Screening Criteria [8] (mg/L)	Groundwater Preliminary COPC (Yes/No)
			Remedial A[3] (mg/L)	Monitoring [4] (mg/L)		Primary (mg/L)	Secondary (mg/L)	Child (mg/L)	Adult (mg/L)		

[4] Remedial action levels for for semi-annual monitoring, as presented in the RMP (IDEQ, 2004b).

[5] State of Idaho Ground Water Quality Rule (IDAPA 58.01.11) (IAC, 2009b).

[6] USEPA primary and secondary Maximum Contaminant Level (MCL), National Primary Drinking Water Regulations (USEPA, 2016b).

[7] Public Health Assessment: Southeast Idaho Phosphate Mining Resource Area: Bannock, Bear Lake, Bingham, and Caribou Counties, Idaho EPA Facility ID: IDN001002245 (ATSDR, 2006).

[8] Proposed COPC screening criteria is based on the following hierarchy:

1) USEPA RSLs for Chemical Contaminants at Superfund Sites (USEPA, 2015a)
2) Remedial action and monitoring levels; Area-Wide Risk Management Plan (IDEQ, 2004b).
3) State of Idaho Ground Water Quality Rule (IDAPA 58.01.11) (IAC, 2009b).
4) USEPA primary and secondary MCLs, National Primary Drinking Water Regulations (USEPA, 2016).
5) Public Health Assessment: Southeast Idaho Phosphate Mining Resource Area (ATSDR, 2006).

[a] Value is secondary standard based on taste/color/smell.

[b] Value reported is based on the USEPA MCL.

[c] Values specified are for chromium III/VI. Consistent with the Agencies and Tribes-approved Remedial Investigation and Feasibility Study Work Plan for the P4 Sites (MWH, 2011), the total chromium results are compared to the hexavalent chromium

[d] Value is 1/4 the groundwater MCL.

[e] Value reported is based on Tier II Secondary Chronic Benchmarks.

[f] The analyte was not selected as a COPC because it is a naturally occuring essential nutrient with low toxicity.

COPC - constituent of potential concern
IDAPA Idaho Administrative Procedures Act
mg/L - milligrams per liter

Table A3-6
Summary of Chemicals of Potential Concern
Henry Site

Analyte	Upland Soil	Riparian Soil	Surface [a] Water	Sediment	Groundwater [b]
Aluminum					
Antimony	X	X		X	
Arsenic	X	X	X	X	X
Barium					
Beryllium					
Boron					
Cadmium	X	X	X	X	
Calcium					
Chromium			X		X
Cobalt	X	X	X	X	X
Copper					
Iron					
Lead					
Magnesium					
Manganese	X	X	X	X	X
Mercury					
Molybdenum					X
Nickel	X	X	X	X	
Potassium					
Radium-226 [c]	X			X	
Radon-222	X				
Selenium	X	X	X	X	X
Silver					
Sodium					
Thallium	X	X	X	X	X
Uranium	X			X	
Vanadium	X	X	X	X	
Zinc				X	

Notes:

[a] Dissolved fraction for all analytes except for selenium, which is expressed as total selenium.

[b] Total fraction for all analytes.

[c] Radium-226 activity data are available for upland soil only; for other media, radium-226 was identified as a chemical of potential concern (COPC) if uranium was identified as a COPC in that medium.

X - chemical of potential concern

Table A3-7
Exposure Parameters for Use in the Human Health Risk Assessment

Exposure Parameter		Units	Native American child	Native American adult		Hypothetical Future Resident child	Hypothetical Future Resident adult		Seasonal Rancher adult		Recreational Hunter adult		Recreational Camper / Hiker child	Recreational Camper / Hiker youth	Recreational Camper / Hiker adult		Recreational Fisher child	Recreational Fisher adult	
General																			
BW = body weight		kg	15	70	a	15	70	a	70	a	70	a	15	55	70	a	15	70	a
ATc = averaging time for carcinogens		days	25,550		a	25,550		a	25,550	a	25,550	a	25,550			a	25,550		a
ATn = averaging time for non-carcinogens																			
	CTE	days	584	2,336	b	584	2,336	b	2,336	b	2,336	b	584	876	1,460	b	584	2,336	b
	RME	days	2,190	8,760	a	2,190	8,760	a	8,760	b	8,760	b	2,190	3,285	5,475	b	2,190	8,760	b
ED = exposure duration																			
	CTE	years	1.6	6.4	b	1.6	6.4	b	6.4	b	6.4	b	1.6	2.4	4	b	1.6	6.4	b
	RME	years	6	24	a	6	24	a	24	b	24	b	6	9	15	b	6	24	b
Soil Direct Exposure Pathways - Oral, Dermal, and Inhalation																			
EF = exposure frequency for soil exposures																			
	CTE	days / year	183	183	c	183	183	c	90	d	8	e	3	3	3	f	5	5	g
	RME	days / year	270	270	c	270	270	c	120	d	14	e	7	7	7	f	22	22	g
IR_{soil} = soil intake rate																			
	CTE	mg/day	100	50	h	100	50	h	50	h	50	h	100	50	50	h	100	50	h
	RME	mg/day	200	100	h	200	100	h	100	h	100	h	200	100	100	h	200	100	h
SA = surface area for soil dermal contact																			
	CTE	cm^2	1,562	5,092	i	1,562	5,092	i	5,092	i	5,092	i	1,562	3,285	5,092	i	1,562	5,092	i
	RME	cm^2	2,434	5,657	i	2,434	5,657	i	5,657	i	5,657	i	2,434	2,434	5,657	i	2,434	5,657	i
AF = soil-to-dermal adherence factor																			
	CTE	mg/cm^2	0.04	0.07	l	0.04	0.07	l	0.1	j	0.1	j	0.04	0.04	0.01	k	0.04	0.07	k
	RME	mg/cm^2	1	0.3	a	1	0.3	a	0.4	j	0.3	a	1	0.3	0.3	a	1	0.3	a
ABS = absorption fraction through skin		unitless	CS	CS	a	CS	CS	a	CS	a	CS	a	CS	CS	CS	a	CS	CS	a
ET = exposure time for dust inhalation																			
	CTE	fraction of a day	1/24	1/24	m	1/24	1/24	m	4/24	o	12/24	n	12/24	12/24	12/24	n	2/24	2/24	p
	RME	fraction of a day	2/24	2/24	a	2/24	2/24	a	12/24	o	1	n	1	1	1	n	4/24	4/24	p
PEF = particulate emission factor																			
	RME	m^3/kg	6.45E+09		a	6.45E+09		a	6.45E+09	a	6.45E+09	a	6.45E+09			a	6.45E+09		a
Ingestion of Plants																			
EF = exposure frequency for plant ingestion		days / year	350		q	350		q	na		na		na				na		
IR_{plant} = plant intake rate																			
	CTE	g/day	30	57	r	30	57	r	na		na		na				na		
	RME	g/day	156	293	r	156	293	r	na		na		na				na		
MLF = mass loading factor		unitless	0.0135		t	0.0135		t	na		na		na				na		
Ingestion of Game																			
EF = exposure frequency for game ingestion		days / year	350		q	na			na		350	q	na				na		
IR_{game} = game intake rate																			
	CTE	g/day	0.095	0.21	s	na			na		43	s	na				na		
	RME	g/day	20	44.5	s	na			na		134	s	na				na		
MLF = mass loading factor		unitless	0		t	na			na		0	t	na				na		
Qp_e = elk fodder intake		kg/day	2.29		u	na			na		2.29	u	na				na		
Fp_e = fraction of year animal on site		unitless	0.0619		v	na			na		0.0619	v	na				na		
Fs_e = fraction of animal's food on site		unitless	1		v	na			na		1	v	na				na		

Table A3-7
Exposure Parameters for Use in the Human Health Risk Assessment

Exposure Parameter		Units	Native American child	Native American adult		Hypothetical Future Resident child	Hypothetical Future Resident adult		Seasonal Rancher adult		Recreational Hunter adult		Recreational Camper / Hiker child	Recreational Camper / Hiker youth	Recreational Camper / Hiker adult		Recreational Fisher child	Recreational Fisher adult	
Qs_e = elk soil intake rate		kg/day	0.0459		[w]	na			na		0.0459	[w]		na			na		
Qw_e = elk water intake rate		L/day	16.1		[x]	na			na		16.1	[x]		na			na		
BWe = elk body weight		g	286,000		[y]	na			na		286,000	[y]		na			na		
Ingestion of Beef																			
EF = exposure frequency for beef ingestion		days / year	na			na			350	[q]	na			na			na		
IR_{beef} = beef intake rate																			
	CTE	g/day	na			na			124	[z]	na			na			na		
	RME	g/day	na			na			476	[z]	na			na			na		
MLF = mass loading factor		unitless	na			na			0	[t]	na			na			na		
Qp_c = cattle fodder intake		kg/day	na			na			11.77	[t]	na			na			na		
Fp_c = fraction of year animal on site		unitless	na			na			0.33	[aa]	na			na			na		
Fs_c = fraction of animal's food on site		unitless	na			na			1	[t]	na			na			na		
Qs_c = cattle soil intake rate		kg/day	na			na			0.39	[t]	na			na			na		
Qw_c = cattle water intake rate		L/day	na			na			53	[t]	na			na			na		
Ingestion of Fish																			
EF = exposure frequency for fish ingestion		days / year	350		[q]	350		[q]	na		na			na			350		[q]
IR_{fish} = fish intake rate									na		na			na					
	CTE	g/day	1.2	3.9	[ab]	1.2	3.9	[ab]	na		na			na			1.2	3.9	[ab]
	RME	g/day	13.7	30.4	[ab]	13.7	30.4	[ab]	na		na			na			13.7	30.4	[ab]
Surface Water Direct Exposure Pathways - Incidental Ingestion and Dermal Contact																			
EF = exposure frequency for surface water																			
	CTE	days / year	75	75	[ac]	5	5	[g]	na		na			na			5	5	[g]
	RME	days / year	144	144	[ac]	22	22	[g]	na		na			na			22	22	[g]
$IR_{surface\ water}$ = surface water incidental intake rate																			
	CTE	mL/day	7.2	7.2	[ad]	7.2	7.2	[ad]	na		na			na			7.2	7.2	[ad]
	RME	mL/day	21.6	21.6	[ad]	21.6	21.6	[ad]	na		na			na			21.6	21.6	[ad]
SA = surface area for surface water dermal contact																			
	CTE	cm^2	933	2,587	[ae]	933	2,587	[ae]	na		na			na			933	2,587	[ae]
	RME	cm^2	1,968	6,362	[ae]	1,968	6,362	[ae]	na		na			na			1,968	6,362	[ae]
DA = absorbed dose per dermal contact event		mg/cm^2-event	CS	CS		CS	CS		CS		na			na			CS	CS	
ET = exposure time for dermal contact																			
	CTE	hours / day	1	1	[af]	1	1	[af]	na		na			na			1	1	[af]
	RME	hours / day	2	2	[af]	2	2	[af]	na		na			na			2	2	[af]
Groundwater Direct Exposure Pathways - Ingestion and Dermal Contact																			
EF = exposure frequency for groundwater																			
	CTE	days / year	na			350	350	[a]	90	[d]	na			na			na		
	RME	days / year	na			350	350	[a]	120	[d]	na			na			na		
$IR_{groundwater}$ = groundwater intake rate																			
	CTE	L/day	na			0.315	0.922	[ag]	0.922	[ag]	na			na			na		
	RME	L/day	na			1.5	2	[a]	2	[a]	na			na			na		

Table A3-7
Exposure Parameters for Use in the Human Health Risk Assessment

Exposure Parameter		Units	Native American child	Native American adult	Hypothetical Future Resident child	Hypothetical Future Resident adult	Seasonal Rancher adult	Recreational Hunter adult	Recreational Camper / Hiker child	Recreational Camper / Hiker youth	Recreational Camper / Hiker adult	Recreational Fisher child	Recreational Fisher adult
SA = surface area for groundwater dermal contact while showering													
	CTE	cm^2	na		6,365	18,979 [ah]	18,979 [ah]	na		na		na	
	RME	cm^2	na		7,694	23,654 [ah]	23,654 [ah]	na		na		na	
DA = absorbed dose per dermal contact event		mg/cm^2-event	na		CS	CS	CS	na		na		na	
ET = exposure time for dermal contact													
	CTE	hours / day	na		0.33	0.25 [ai]	0.25 [ai]	na		na		na	
	RME	hours / day	na		1	0.58 [ai]	0.58 [ai]	na		na		na	

Notes:

^oC - degrees Celsius
cm - centimeters
cm^2 - square centimeter
cm^3 - cubic centimeter
CTE - central tendency estimate
CS - chemical specific
g - gram
kg - kilogram
L - liters
m^3 - cubic meters
mg - milligram
mL - milliliter
na - not applicable
RME - reasonable maximum estimate

[a] Idaho Department of Environmental Quality (IDEQ). 2004. Idaho Risk Evaluation Manual.

[b] For the RME scenario, an adult recreational hunter who resides in the area was assumed to hunt every season for 24 years; the recreational camper/hiker and was assumed to camp in the area as a child, youth and adult for 30 years; and an adult seasonal rancher was assumed to graze cattle in the area for 24 years. These RME assumptions are consistent with an exposure duration of 30 years suggested in the Idaho Risk Evaluation Manual (IDEQ, 2004a). For the CTE scenario, the exposure duration for all receptors were based on a 50th percentile residential occupancy period of 8 years (USEPA, 2011). The CTE exposure durations were calculated by multiplying each RME exposure duration by a factor of 8/30.

[c] The RME exposure frequency for direct soil contact is from IDEQ (2004a); the CTE exposure frequency assumes that the ground is covered in snow for half of the year.

[d] Cattle are assumed to graze at the Site for 90 (CTE) to 120 (RME) days per year; seasonal ranchers are conservatively assumed to reside at the site while cattle are grazing.

[e] Archery season for elk is a month (September), any weapon season for elk is October 25 to November 15 and muzzle loader season is November 16 to 30. The exposure frequency is based on the assumption that a hunter goes out every weekend during the archery season (CTE) or a total of 14 days over the entire season (RME).

[f] Based on one three day weekend (CTE) or week long (RME) camping trip per year.

[g] A recreational fisher, or hypothetical future resident or Native American receptor who fishes, is expected to visit the Site once a week from mid spring (May 1st) till mid fall (September 30) (RME). The CTE scenario assumes that a receptor fishes once per month for the same period.

[h] The RME soil ingestion rates are from IDEQ (2004a); CTE soil ingestion rates are central tendency values from Table 5-1 of USEPA's Exposure Factors Handbook (2011).

[i] The RME dermal surface area for soil exposures is from IDEQ (2004a). The CTE is from Table 7-2 of USEPA's Exposure Factors Handbook (2011), and assumes that the face, forearms, hands, and lower legs are exposed to soil.

[j] Equal to the geometric mean (CTE) and 95th percentile (RME) for a farmer presented in USEPA (2004) Exhibit 3-3.

[k] Equal to the geometric mean for a child playing in dry soil (child) and adult playing outdoor sports - soccer (adult) presented in USEPA (2004) Exhibit 3-3.

[l] Equal to the geometric mean for a child playing indoors and outdoors (child) and an adult residential gardener presented in USEPA (2004) Exhibit 3-3.

[m] Based on 50% of the RME assumption (Refer to footnote "a").

[n] Time outdoors for tent camping (RME) and RV camping (CTE).

[o] The exposure time for a seasonal rancher is assumed to be similar to the time spent outdoor for someone on a farm. The 95th and 50th percentile time spent outdoor for someone on a farm in the summer is 12 hours and 4 hours, respectively (USEPA, 2011).

[p] Recreational fishers, hypothetical residents, and Native Americans are assumed to spend 4 hours per day fishing (RME assumption). The CTE exposure time for fishing is based on 50% of the RME assumption. Note that the riparian soil exposure frequency and time for the Native American is equivalent to the upland soil exposure frequency and time to facilitate comparison of these media; therefore the riparian exposures associated with fishing were not added to the general riparian soil exposures for this receptor.

[q] Ingestion frequency (days per year) for home grown, hunted, and foraged food was assumed to match the number of days at home in IDEQ (2004). Although it is conservatively assumed that home grown, hunted, and foraged foods are eaten daily, the daily food ingestion rates derived from the USEPA (2011) do not assume that these foods comprise an individual's entire daily food intake.

[r] Consumption of home grown produce from Table 13-1 of USEPA (2011): per capita for populations that garden or farm, adjusted for cooking. Body weight specific ingestion rates in Table 13-1 were adjusted to total grams consumed using body weights in Table 8-1 of USEPA (2011). The CTE and RME ingestion rates are equal to the mean and 95th percentile estimates of consumption rates, respectively.

[s] The ingestion of game rates for a seasonal hunter were mean and 95th percentile time-weighted ingestion rate for ages 16-46 from Table 13-41 of USEPA's Exposure Factors handbook (2011) and adjusted for 29.7% post-cooking loss (Table 13-69 from USEPA 2011). The CTE (mean) and RME (99th percentile) adult Native American ingestion of game rates were based on the mean and 100th percentile values for "other" consumers from Table 11-6 of the 1997 Exposure Factors Handbook (USEPA, 1997b). The child Native American ingestion rates were estimated from the adult ingestion rates assuming a child eats 45% of the meat consumed by an adult (based on values in Table 13-1 of USEPA, 2011). All grams per kilogram per day adult ingestion rates were converted to grams per kilogram assuming a body weight of 70 kilograms.

Table A3-7
Exposure Parameters for Use in the Human Health Risk Assessment

Exposure Parameter	Units	Native American		Hypothetical Future Resident		Seasonal Rancher	Recreational Hunter	Recreational Camper / Hiker			Recreational Fisher	
		child	adult	child	adult	adult	adult	child	youth	adult	child	adult

[t] Produce mass loading factor (MLF) obtained from RAIS (2013) is based on mass loading data for lettuce; this value was adjusted for wet weight using a moisture content of 5.2% for lettuce obtained from Appendix G of USEPA (1996). Pasture MLF assumed to be equal to zero, as described in Section 3.3.2.2 of the BRA. The fraction of an animal's food on site was assumed to be 100% during the time the animal is on site. Forage, water, and soil ingestion rates are from RAIS (2013).

[u] The game animal fodder intake was estimated using Equation 29 in Nagy (2001).

[v] The fraction of year an animal is on site was estimated using the Henry Site area and a home range of 16,640 acre (Kuck, 2003a); during that fraction of the year the value of fraction of food on site is 1.

[w] Soil ingestion rates as percent of diet from Beyer (1994).

[x] Calculated using Equation 3-17 for ingestion rates for mammal from USEPA, 1993.

[y] Senseman, R. 2002. "Cervus elaphus" (On-line), Animal Diversity Web. Accessed February 22, 2011. http://animaldiversity.ummz.umich.edu/site/accounts/information/Cervus_elaphus.html.

[z] The CTE (50th percentile) and RME (95th percentile) consumer-only intake rates for home grown beef (g/kg-day) from Table 13-33 of USEPA (2011); adjusted using adult body weight from Table 8-1 of USEPA (2011).

[aa] The beef cattle was assumed to graze the Henry Site 120 days/year because snowpack and ice are present approximately six months of the year.

[ab] Adult fish ingestion rate is the median (CTE) and 95th percentile (RME) fish ingestion rate for people with fishing licenses from Minnesota, presented in Table 10-84 of USEPA (2011). The child fish ingestion rate is the median (CTE) and 95th percentile (RME) fish ingestion rate for youth 0-14 years old in Minnesota (Table 10-84; USEPA, 2011)

[ac] Native Americans are assumed to gather food or medical plants in or near streams every day (RME) or four days per week (CTE) during June, July, August and September. Native Americans who fish are assumed to be exposed to surface water an additional 22 (RME) or 5 (CTE) days per year.

[ad] RME (upper confidence limit) and CTE (mean) incidental surface water ingestion rates for a recreational fisher, and a Native American or hypothetical resident who fishes, were derived from Table 3-93 of USEPA (2011). Native Americans collecting culturally significant riparian vegetation are assumed to have ingestion rates similar to those for fishing.

[ae] Recreational fishers, hypothetical residents who fish, and Native Americans who fish and collect culturally significant vegetation are potentially dermally exposed to surface water; CTE assumes hands, forearms, and face are exposed, and RME assumes that feet and lower legs are also exposed. Surface areas were calculated according to Table 7-2 of USEPA (2011). For the purposes of this calculation, the surface area of the face was assumed to be 1/3 that of the head, forearms were assumed to represent 45% of the arms, and lower legs were assumed to represent 40% of the legs (USEPA, 2011)

[af] Recreational fishers, as well as hypothetical residents and Native Americans who fish are assumed to have two hours of contact with surface water per day fishing (RME). Native Americans are assumed to have an additional two hours of contact with surface water per week while gathering culturally significant plants. The CTE for both activities is based on 50% of the RME assumption.

[ag] Intake rate is the mean from Table 3-1 of USEPA (2011).

[ah] Mean (CTE) and 95th percentile (RME) From Table 7-1 of USEPA (2011).

[ai] USEPA (2004) Exhibit 3-2.

Table A3-8
Summary Statistics and Derived 95% UCLs for Constituents of Potential Concern and Constituents of Potential Ecological Concern in Upland Soil
Henry Site

Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Assumed Distribution	ProUCL 95% UCL [a] (mg/kg)	EPC [b] (mg/kg)
Antimony	60	55	92	9.15	0.685	Nonparametric	4.81	4.81
Arsenic	60	60	100	45.5	4.00	Normal	24.9	24.9
Boron	60	48	80	39.0	1.99	Nonparametric	15.5	15.5
Cadmium	60	60	100	59.5	2.13	Normal	32.5	32.5
Chromium	60	60	100	519	19.9	Normal	271	271
Cobalt	60	60	100	11.9	2.98	Normal	7.74	7.74
Copper	60	60	100	172	11.1	Nonparametric	124	124
Manganese	60	60	100	2,040	68.8	Nonparametric	658	658
Mercury	60	60	100	0.503	0.0221	Nonparametric	0.396	0.396
Molybdenum	60	56	93	35.7	1.41	Nonparametric	16.8	16.8
Nickel	60	60	100	425	22.5	Normal	212	212
Radium-226 [c]	124,686	124,686	100	58.8	58.8	Normal	12.6	12.6
Radon-222 [d]	15	15	100	13,327	2,941	Gamma	8,084	8,084
Selenium	77	76	99	318	0.687	Gamma	46.4	46.4
Silver	60	59	98	7.30	0.224	Nonparametric	3.70	3.70
Thallium	60	60	100	2.31	0.171	Normal	1.31	1.31
Uranium	60	60	100	74.4	1.64	Nonparametric	40.5	40.5
Vanadium	60	60	100	584	22.3	Normal	212	212
Zinc	60	60	100	1,610	121	Normal	890	890

Notes:

All concentrations in mg/kg except for radium-226, which is in picoCuries per gram (pCi/g) and radon-222, which is in picoCuries per cubic meter (pCi/m^3).

% - percent
mg/kg - milligram per kilogram
EPC - Exposure point concentration
UCL - Upper Confidence Limit

[a] Calculated using ProUCL version 5.00. If ProUCL recommended the 97.5% or the 99% UCL, the recommended UCL was selected.
[b] The EPC is based on either the 95% UCL on the mean concentration or the maximum concentration.
[c] Radium-226 concentrations were calculated from gamma count measurements as described in the On-Site and Background Areas Radiological and Soil Investigation Summary Report (MWH, 2015).
[d] Radon-222 concentrations were calculated from radon flux data as described in the On-Site and Background Areas Radiological and Soil Investigation Summary Report (MWH, 2015).

Table A3-9
Summary Statistics and Derived 95% UCLs for Upland Vegetation for Constituents of Potential Concern and Constituents of Potential Ecological Concern in Upland Soil
Henry Site

Plant Type / Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Assumed Distribution	ProUCL 95% UCL [a] (mg/kg)	EPC [b] (mg/kg)	
Non-Culturally Significant Plants									
Antimony	80	1	1	0.518	0.518	NA	NC	0.518	c
Arsenic	80	65	81	10.2	0.0730	Nonparametric	1.69	1.69	
Cadmium	81	81	100	5.29	0.254	Gamma	1.57	1.57	
Cobalt	80	6	8	0.298	0.126	Nonparametric	0.126	0.126	
Manganese	80	80	100	54.8	8.99	Normal	28.5	28.5	
Nickel	80	80	100	17.4	0.705	Gamma	4.69	4.69	
Selenium	138	91	66	146	0.451	Nonparametric	16.9	16.9	
Thallium	80	79	99	0.713	0.0130	Nonparametric	0.250	0.250	
Uranium	80	7	9	1.27	0.157	Nonparametric	0.144	0.144	
Vanadium	80	79	99	13.1	0.269	Nonparametric	1.24	1.24	
Culturally Significant Plants									
Antimony	5	0	0	ND	ND	NA	NC	0.500	d
Arsenic	5	2	40	0.135	0.111	NA	NC	0.135	c
Cadmium	5	5	100	5.56	0.132	Normal	5.06	5.06	
Cobalt	5	1	20	0.502	0.502	NA	NC	0.502	
Manganese	5	5	100	70.1	20.7	Normal	64.0	64.0	
Nickel	5	3	60	4.58	1.06	NA	NC	4.58	c
Selenium	5	5	100	5.26	0.504	Normal	3.75	3.75	
Thallium	5	0	0	ND	ND	NA	NC	0.00986	d
Uranium	5	0	0	ND	ND	NA	NC	0.0986	d
Vanadium	5	3	60	1.09	0.454	NA	NC	1.09	c
All Plants									
Antimony	85	1	1	0.518	0.518	NA	NC	0.518	c
Arsenic	85	67	79	10.2	0.0730	Nonparametric	1.60	1.60	
Boron	85	81	95	47.3	2.50	Nonparametric	18.4	18.4	
Cadmium	86	86	100	5.56	0.132	Lognormal	1.71	1.71	
Chromium	85	85	100	18.2	1.38	Normal	3.26	3.26	

Table A3-9
Summary Statistics and Derived 95% UCLs for Upland Vegetation for Constituents of Potential Concern and Constituents of Potential Ecological Concern in Upland Soil
Henry Site

Plant Type Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Assumed Distribution	ProUCL 95% UCL [a] (mg/kg)	EPC [b] (mg/kg)
Cobalt	85	7	8	0.502	0.126	Nonparametric	0.136	0.136
Copper	86	86	100	15.4	3.24	Normal	7.08	7.08
Manganese	85	85	100	70.1	8.99	Normal	29.7	29.7
Mercury	85	24	28	0.0687	0.00761	Nonparametric	0.0138	0.0138
Molybdenum	86	81	94	125	1.53	Nonparametric	19.9	19.9
Nickel	85	83	98	17.4	0.705	Nonparametric	4.54	4.54
Selenium	143	96	67	146	0.451	Nonparametric	16.4	16.4
Silver	85	5	6	0.164	0.0546	Nonparametric	0.0516	0.0516
Thallium	85	79	93	0.713	0.0130	Nonparametric	0.239	0.239
Uranium	85	7	8	1.27	0.157	Nonparametric	0.141	0.141
Vanadium	85	82	96	13.1	0.269	Nonparametric	1.24	1.24
Zinc	86	86	100	231	12.8	Gamma	56.0	56.0

Notes:

% - percent
EPC - Exposure point concentration
mg/kg - milligram per kilogram
NA - not applicable
NC - Not calculated
ND - not detected
UCL - Upper Confidence Limit

[a] Calculated using ProUCL version 5.00. If ProUCL recommended the 97.5% or the 99% UCL, the recommended UCL was selected.
[b] The EPC is based on either the 95% UCL on the mean concentration or the maximum concentration.
[c] ProUCL did not calculate a 95% UCL for this chemical due to insufficient number of samples or insufficient number of detected values within the data set.
[d] This chemical of potential concern was not detected in tissue samples from culturally significant plants, therefore the maximum detection limit from culturally significant plant tissue samples was used in place of the maximum detected concentration in Tier I calculations, and as the EPC in Tier II calculations.

Table A3-10
Summary Statistics and Derived 95% UCLs for Constituents of Potential Concern and Constituents of Potential Ecological Concern in Riparian Soil
Henry Site

Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Assumed Distribution	ProUCL 95% UCL [a] (mg/kg)	EPC [b] (mg/kg)
Antimony	6	5	83	7.00	4.50	Nonparametric	6.17	6.17
Arsenic	6	6	100	4.99	1.12	Normal	4.25	4.25
Boron	6	6	100	5.90	3.50	Normal	5.80	5.80
Cadmium	34	34	100	67.3	0.392	Lognormal	7.38	7.38
Chromium	34	34	100	467	14.4	Nonparametric	123	123
Cobalt	6	6	100	8.73	4.25	Normal	7.98	7.98
Copper	34	34	100	56.0	5.80	Gamma	22.0	22.0
Manganese	6	6	100	1,080	145	Normal	901	901
Mercury	6	6	100	0.0240	0.0120	Normal	0.0235	0.0235
Molybdenum	34	27	79	14.8	0.287	Nonparametric	4.64	4.64
Nickel	34	34	100	251	10.3	Nonparametric	70.4	70.4
Selenium	34	28	82	45.0	0.700	Nonparametric	14.9	14.9
Thallium	6	6	100	0.223	0.105	Normal	0.200	0.200
Uranium	6	6	100	1.66	0.748	Normal	1.43	1.43
Vanadium	34	34	100	773	14.7	Nonparametric	165	165
Zinc	34	34	100	1,600	49.7	Nonparametric	397	397

Notes:

% - percent
EPC - Exposure point concentration
mg/kg - milligram per kilogram
UCL - Upper Confidence Limit

[a] Calculated using ProUCL version 5.00. If ProUCL recommended the 97.5% or the 99% UCL, the recommended UCL was selected.
[b] The EPC is based on either the 95% UCL on the mean concentration or the maximum concentration.

Table A3-11
Summary Statistics and Derived 95% UCLs for Riparian Vegetation for Constituents of Potential Concern and Constituents of Potential Ecological Concern in Riparian Soil
Henry Site

Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Assumed Distribution	ProUCL 95% UCL [a] (mg/kg)	EPC [b] (mg/kg)
Cadmium	28	21	75	2.87	0.0500	Nonparametric	0.692	0.692
Copper	28	28	100	7.70	1.90	Normal	4.93	4.93
Molybdenum	28	28	100	19.3	0.400	Lognormal	3.15	3.15
Selenium	28	7	25	65.0	0.500	Nonparametric	8.65	8.65
Zinc	28	28	100	335	11.0	Nonparametric	95.6	95.6

Notes:

% - percent
EPC - Exposure point concentration
mg/kg - milligram per kilogram
UCL - Upper Confidence Limit

[a] Calculated using ProUCL version 5.00. If ProUCL recommended the 97.5% or the 99% UCL, the recommended UCL was selected.
[b] The EPC is based on either the 95% UCL on the mean concentration or the maximum concentration.

Table A3-12
Summary Statistics and Derived 95% UCLs for Constituents of Potential Concern and Constituents of Potential Ecological Concern in Surface Water
Henry Mine

Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/L)	Minimum Detected Concentration (mg/L)	Assumed Distribution	ProUCL 95% UCL [a] (mg/L)	EPC [b] (mg/L)
All Surface Water Stations								
Aluminum, dissolved	33	8	24	0.905	0.0300	Nonparametric	0.165	0.165
Antimony, Dissolved	30	5	17	0.00230	0.000400	Nonparametric	0.000657	0.000657
Arsenic, Dissolved	30	16	53	0.0224	0.000530	Nonparametric	0.00928	0.00928
Barium, Dissolved	24	24	100	0.0810	0.00600	Normal	0.0509	0.0509
Boron, Dissolved	12	9	75	0.121	0.0100	Nonparametric	0.0857	0.0857
Cadmium, dissolved	125	20	16	0.0352	0.0000120	Nonparametric	0.00371	0.00371
Chromium, dissolved	71	37	52	0.00760	0.000200	Nonparametric	0.00159	0.00159
Cobalt, Dissolved	30	6	20	0.0141	0.000964	Nonparametric	0.00417	0.00417
Copper, Dissolved	30	6	20	0.00379	0.000550	Nonparametric	0.00263	0.00263
Manganese, dissolved	39	37	95	2.44	0.00120	Nonparametric	1.17	1.17
Mercury, Dissolved	30	0	0	ND	ND	NA	NC	ND
Molybdenum, Dissolved	30	8	27	0.0400	0.00370	Nonparametric	0.0111	0.0111
Nickel, dissolved	88	81	92	1.26	0.000300	Nonparametric	0.138	0.138
Selenium, total	126	86	68	0.970	0.000585	Nonparametric	0.102	0.102
Silver, Dissolved	30	0	0	ND	ND	NA	NC	ND
Thallium, Dissolved	30	5	17	0.000348	0.0000590	Nonparametric	0.0000813	0.0000813
Uranium, dissolved	52	49	94	0.0206	0.000700	Nonparametric	0.00586	0.00586
Vanadium, dissolved	123	72	59	0.0885	0.000400	Nonparametric	0.00989	0.00989
Zinc, dissolved	88	58	66	4.73	0.000800	Nonparametric	0.484	0.484
Surface Water Stations with Fish Present [c]								
Antimony, Dissolved	2	0	0	ND	ND	NA	NC	ND
Arsenic, Dissolved	2	2	100	0.000750	0.000530	NA	NC	0.000750
Cadmium, dissolved	38	1	3	0.0000120	0.0000120	NA	NC	0.0000120
Chromium, dissolved	14	5	36	0.00142	0.000230	Nonparametric	0.000569	0.000569
Cobalt, Dissolved	2	1	50	0.000964	0.000964	NA	NC	0.000964
Manganese, dissolved	5	5	100	0.0121	0.00265	Normal	0.0117	0.0117
Nickel, dissolved	21	20	95	0.00634	0.000500	Nonparametric	0.00253	0.00253
Selenium, total	38	19	50	0.0460	0.000675	Nonparametric	0.00423	0.00423

Table A3-12
Summary Statistics and Derived 95% UCLs for Constituents of Potential Concern and Constituents of Potential Ecological Concern in Surface Water
Henry Mine

Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/L)	Minimum Detected Concentration (mg/L)	Assumed Distribution	ProUCL 95% UCL [a] (mg/L)	EPC [b] (mg/L)
Thallium, Dissolved	2	0	0	ND	ND	NA	NC	ND
Uranium, dissolved	11	11	100	0.00207	0.000938	Normal	0.00166	0.00166
Vanadium, dissolved	38	19	50	0.0885	0.000700	Nonparametric	0.0118	0.0118
Zinc, dissolved	21	17	81	0.0141	0.000800	Nonparametric	0.00664	0.00664

Notes:

% - percent
mg/L - milligram per liter
NA - not applicable
NC - not calculated
ND - not detected
UCL - upper confidence limit

[a] Calculated using ProUCL version 5.00. If ProUCL recommended the 97.5% or the 99% UCL, the recommended UCL was selected.
[b] The EPC is based on either the 95% UCL on the mean concentration or the maximum concentration.
[c] Human health cancer risks and noncancer hazards associated with consumption of fish harvested from surface water at the Henry Site and vicinity were calculated based on surface water data from sampling locations with fish present or likely to be present, as documented in Table 4-16 of this Remedial Investigation Report. Sediment data were used to model fish tissue concentrations when surface water data were not available at these locations.

Table A3-13
Summary Statistics and Derived 95% UCLs for Constituents of Potential Concern and Constituents of Potential Ecological Concern in Sediment
Henry Site

Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Assumed Distribution	ProUCL 95% UCL [a] (mg/kg)	EPC [b] (mg/kg)
All Sediment Stations								
Antimony	18	13	72	8.50	3.60	Nonparametric	6.03	6.03
Arsenic	18	18	100	10.6	1.53	Normal	7.49	7.49
Boron	18	18	100	17.4	4.40	Gamma	10.2	10.2
Cadmium	39	39	100	104	0.481	Nonparametric	27.1	27.1
Chromium	39	39	100	1,030	10.7	Nonparametric	217	217
Cobalt	18	18	100	10.6	2.77	Normal	7.46	7.46
Copper	18	18	100	68.8	10.6	Normal	41.5	41.5
Manganese	18	18	100	2,580	119	Gamma	1,130	1,130
Mercury	18	18	100	0.236	0.0200	Normal	0.110	0.110
Molybdenum	18	12	67	10.8	2.20	Nonparametric	4.29	4.29
Nickel	40	40	100	1,110	8.60	Nonparametric	199	199
Selenium	40	35	88	148	0.500	Nonparametric	49.8	49.8
Silver	18	18	100	2.16	0.117	Gamma	1.06	1.06
Thallium	18	18	100	2.17	0.121	Normal	1.12	1.12
Uranium	18	18	100	90.0	1.65	Gamma	30.6	30.6
Vanadium	40	40	100	940	12.7	Nonparametric	231	231
Zinc	40	40	100	7,940	42.0	Nonparametric	1,385	1,385
Sediment Stations with Fish Present [c]								
Antimony	2	1	50	4.70	4.70	NA	NC	4.70
Arsenic	2	2	100	1.99	1.53	NA	NC	1.99
Cadmium	9	9	100	1.42	0.660	Normal	1.29	1.29
Chromium	9	9	100	36.0	17.5	Normal	28.8	28.8
Cobalt	2	2	100	5.55	5.36	NA	NC	5.55
Manganese	2	2	100	316	262	NA	NC	316
Nickel	9	9	100	16.2	11.3	Normal	14.7	14.7
Selenium	9	7	78	1.67	0.500	Nonparametric	1.33	1.33
Thallium	2	2	100	0.122	0.121	NA	NC	0.122
Uranium	2	2	100	2.28	1.65	NA	NC	2.28

Table A3-13
Summary Statistics and Derived 95% UCLs for Constituents of Potential Concern and Constituents of Potential Ecological Concern in Sediment
Henry Site

Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Assumed Distribution	ProUCL 95% UCL [a] (mg/kg)	EPC [b] (mg/kg)
Vanadium	9	9	100	34.3	15.7	Normal	27.8	27.8
Zinc	9	9	100	92.7	49.0	Normal	79.6	79.6

Notes:

% - percent
EPC - Exposure point concentration
mg/kg - milligram per kilogram
NC - not calculated
ND - not detected
UCL - Upper Confidence Limit

[a] Calculated using ProUCL version 5.00. If ProUCL recommended the 97.5% or the 99% UCL, the recommended UCL was selected.
[b] The EPC is based on either the 95% UCL on the mean concentration or the maximum concentration.
[c] Human health cancer risks and noncancer hazards associated with consumption of fish harvested from surface water at the Henry Site and vicinity were calculated based on sediment data from sampling locations with fish present or likely to be present, as documented in Table 4-16 of this Remedial Investigation Report. Sediment data were used to model fish tissue concentrations only when surface water data were not available.

Table A3-14
Summary Statistics and Derived 95% UCLs for Constituents of Potential Concern in Groundwater
Henry Site

Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/L)	Minimum Detected Concentration (mg/L)	Assumed Distribution	ProUCL 95% UCL [a] (mg/L)	EPC [b] (mg/L)
Arsenic, total	12	7	58	0.00430	0.000500	Nonparametric	0.00227	0.00227
Chromium, total	26	16	62	0.00380	0.000400	Nonparametric	0.00185	0.00185
Cobalt, total	12	2	17	0.0100	0.0100	NA	NC	0.0100 [c]
Manganese, total	49	45	92	3.39	0.000547	Nonparametric	0.592	0.592
Molybdenum, total	12	2	17	0.110	0.0300	Nonparametric	0.0373	0.110 [c]
Selenium, total	66	50	76	0.219	0.000563	Nonparametric	0.0479	0.0479
Thallium, total	12	6	50	0.000900	0.000100	Nonparametric	0.000505	0.000505

Notes:

% - percent
EPC - Exposure point concentration
mg/L - milligram per liter
NA - not applicable
NC - not calculated
UCL - Upper Confidence Limit

[a] Calculated using ProUCL version 5.00. If ProUCL recommended the 97.5% or the 99% UCL, the recommended UCL was selected.
[b] The EPC is based on either the 95% UCL on the mean concentration or the maximum concentration.
[c] ProUCL did not calculate a 95% UCL for this chemical, or the calculated 95% UCL was not used in the risk assessment, due to insufficient number of samples or insufficient number of detected values within the data set.

Table A3-15
Summary Statistics and Derived 95% UCLs for Constituents of Potential Concern and Constituents of Potential Ecological Concern in Upland Soil
Background

Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Assumed Distribution	95% UCL [a] (mg/kg)	EPC [b] (mg/kg)
Antimony	80	59	74	3.60	0.0300	Non-parametric	1.04	1.04
Arsenic	80	79	99	19.0	2.55	Gamma	8.20	8.20
Boron	80	62	78	25.0	1.92	Non-parametric	9.86	9.86
Cadmium	80	79	99	44.0	0.538	Non-parametric	13.6	13.6
Chromium	80	79	99	420	9.87	Non-parametric	108	108
Cobalt	80	79	99	13.3	3.37	Gamma	7.92	7.92
Copper	80	79	99	82.0	8.60	Normal	27.0	27.0
Manganese	80	79	99	3,990	300	Non-parametric	1,423	1,423
Mercury	79	78	99	0.320	0.0110	Non-parametric	0.0723	0.0723
Molybdenum	79	50	63	29.0	0.780	Non-parametric	7.94	7.94
Nickel	79	78	99	230	12.5	Non-parametric	69.8	69.8
Radium-226 [c]	39,781	39,781	100	27.2	NA	Normal	4.80	4.80
Radon-222 [d]	120	120	100	12,684	NA	Non-parametric	3,845	3,845
Selenium	79	78	99	29.0	0.250	Non-parametric	6.67	6.67
Silver	80	71	89	2.40	0.0480	Non-parametric	0.371	0.371
Thallium	79	78	99	1.30	0.118	Non-parametric	0.510	0.510
Uranium	80	75	94	42.0	0.395	Non-parametric	10.2	10.2
Vanadium	79	78	99	370	10.7	Non-parametric	93.3	93.3
Zinc	79	78	99	1,200	57.7	Non-parametric	473	473

Notes:

All concentrations in mg/kg except for radium-226, which is in picoCuries per gram (pCi/g) and radon-222, which is in picoCuries per cubic meter (pCi/m^3)

% - percent
EPC - Exposure point concentration
mg/kg - milligram per kilogram
NA - not applicable
UCL - Upper Confidence Limit

Table A3-15
Summary Statistics and Derived 95% UCLs for Constituents of Potential Concern and Constituents of Potential Ecological Concern in Upland Soil
Background

Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Assumed Distribution	95% UCL [a] (mg/kg)	EPC [b] (mg/kg)

[a] Calculated using ProUCL version 4.1.00. If ProUCL 4.1.00 recommended the 97.5% or the 99% UCL, the recommended UCL was selected.

[b] The EPC is based on either the 95% UCL on the mean concentration or the maximum concentration.

[c] Calculated from gamma count measurements as described in the On-Site and Background Areas Radiological and Soil Investigation Summary Report (MWH, 2015). A minimum radium-226 concentration less than zero is possible due to the regression; the minimum concentration at the Henry Site is indicated as NA here.

[d] Radon-222 concentrations were calculated from radon flux data as described in the On-Site and Background Areas Radiological and Soil Investigation Summary Report (MWH, 2015).

Table A3-16
Summary Statistics and Derived 95% UCLs for Upland Vegetation for Constituents of Potential Concern and Constituents of Potential Ecological Concern in Upland Soil
Background

Plant Type / Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentratio (mg/kg)	Minimum Detected Concentratio (mg/kg)	Assumed Distribution	95% UCL [a] (mg/kg)	EPC [b] (mg/kg)
Non-Culturally Significant Plant								
Antimony	84	1	1.19	5.41	5.41	NA	NC	5.41
Boron	84	81	96.4	68.3	2.76	Non-parametric	22.5	22.5
Cadmium	83	78	94.0	1.58	0.0248	Non-parametric	0.410	0.410
Mercury	75	10	13.3	0.0589	0.0117	Non-parametric	0.0154	0.0154
Molybdenum	78	36	46.2	8.91	1.48	Non-parametric	2.57	2.57
Selenium	84	74	88.1	7.28	0.109	Non-parametric	0.920	0.920
Silver	84	13	15.5	0.598	0.0505	Non-parametric	0.0827	0.0827
Thallium	84	6	7.14	0.0257	0.0109	Non-parametric	0.0117	0.0117
Uranium	84	1	1.19	0.108	0.108	NA	NC	0.108
Culturally Significant Plant								
Antimony	76	0	0	ND	ND	NA	NC	8.62
Boron	75	74	98.7	52.0	6.32	Non-parametric	23.9	23.9
Cadmium	76	69	90.8	1.95	0.0262	Non-parametric	0.624	0.624
Mercury	70	12	17.1	0.0876	0.00946	Non-parametric	0.0175	0.0175
Molybdenum	74	8	10.8	2.71	1.54	Non-parametric	1.65	1.65
Selenium	76	67	88.2	3.18	0.0992	Non-parametric	0.493	0.493
Silver	74	6	8.11	0.299	0.0925	Non-parametric	0.106	0.106
Thallium	76	1	1.32	0.0117	0.0117	NA	NC	0.0117
Uranium	76	2	2.63	0.162	0.101	NA	NC	0.162
All Plants								
Antimony	160	1	0.625	5.41	5.41	NA	NC	5.41
Boron	159	155	97.5	68.3	2.76	Non-parametric	22.5	22.5
Cadmium	159	147	92.5	1.95	0.0248	Non-parametric	0.461	0.461
Mercury	145	22	15.2	0.0876	0.00946	Non-parametric	0.0149	0.0149
Molybdenum	152	44	28.9	8.91	1.48	Non-parametric	2.09	2.09

Table A3-16
Summary Statistics and Derived 95% UCLs for Upland Vegetation for Constituents of Potential Concern and Constituents of Potential Ecological Concern in Upland Soil
Background

Plant Type Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentratio (mg/kg)	Minimum Detected Concentratio (mg/kg)	Assumed Distribution	95% UCL [a] (mg/kg)	EPC [b] (mg/kg)
Non-Culturally Significant Plant								
Selenium	160	141	88.1	7.28	0.0992	Non-parametric	0.662	0.662
Silver	158	19	12.0	0.598	0.0505	Non-parametric	0.0732	0.0732
Thallium	160	7	4.38	0.0257	0.0109	Non-parametric	0.0113	0.0113
Uranium	160	3	1.88	0.162	0.101	NA	NC	0.162

Notes:

% - percent
EPC - Exposure point concentration
mg/kg - milligram per kilogram
NA - not applicable
NC - not calculated
ND - not detected
UCL - Upper Confidence Limit

[a] Calculated using ProUCL version 4.1.00. If ProUCL 4.1.00 recommended the 97.5% or the 99% UCL, the recommended UCL was selected.
[b] The EPC is based on either the 95% UCL on the mean concentration or the maximum concentration. Antimony was not detected in culturally significant upland plants from background areas; therefore, the EPC for antimony is equal to the maximum detection limit.

Table A3-17
Summary Statistics and Derived 95% UCLs for Constituents of Potential Concern and Constituents of Potential Ecological Concern in Riparian Soil
Background

Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Assumed Distribution	ProUCL 95% UCL [a] (mg/kg)	EPC [b] (mg/kg)
Antimony	8	4	50	5.50	4.60	NA	NC	5.50
Arsenic	8	8	100	5.44	2.78	Normal	4.43	4.43
Boron	8	8	100	11.2	5.60	Normal	9.72	9.72
Cadmium	17	17	100	4.40	0.600	Normal	2.81	2.81
Chromium	17	17	100	42.5	16.7	Gamma	27.9	27.9
Cobalt	8	8	100	10.1	4.48	Normal	8.25	8.25
Copper	14	14	100	21.1	10.5	Normal	18.5	18.5
Manganese	8	8	100	1,080	124	Normal	655	655
Mercury	8	8	100	0.0690	0.0235	Normal	0.0491	0.0491
Molybdenum	16	6	38	0.700	0.430	Kaplan-Meier	0.508	0.508
Nickel	17	17	100	26.6	10.4	Normal	20.2	20.2
Selenium	17	13	76	1.80	0.500	Kaplan-Meier	1.12	1.12
Thallium	8	8	100	0.428	0.160	Normal	0.333	0.333
Uranium	8	8	100	3.76	1.60	Normal	2.91	2.91
Vanadium	17	17	100	57.3	22.9	Gamma	37.0	37.0
Zinc	17	17	100	158	42.0	Normal	117	117

Notes:
% - percent
EPC - Exposure point concentration
mg/kg - milligram per kilogram
NA - not applicable
NC - not calculated
% - percent
UCL - Upper Confidence Limit

[a] Calculated using ProUCL version 4.1.00. If ProUCL 4.1.00 recommended the 97.5% or the 99% UCL, the recommended UCL was selected.
[b] The EPC is based on either the 95% UCL on the mean concentration or the maximum concentration.

Table A3-18
Summary Statistics and Derived 95% UCLs for Riparian Vegetation for Constituents of Potential Concern and Constituents of Potential Ecological Concern in Riparian Soil
Background

Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Assumed Distribution	ProUCL 95% UCL [a] (mg/kg)	EPC [b] (mg/kg)
Cadmium	9	9	100	0.900	0.100	Gamma	0.552	0.552
Molybdenum	9	9	100	2.58	0.630	Normal	1.76	1.76
Selenium	9	1	11	0.800	0.800	NA	NC	0.800

Notes:

% - percent

EPC - Exposure point concentration

mg/kg - milligram per kilogram

NA - not applicable

NC - not calculated

UCL - Upper Confidence Limit

[a] Calculated using ProUCL version 4.1.00. If ProUCL 4.1.00 recommended the 97.5% or the 99% UCL, the recommended UCL was selected.

[b] The EPC is based on either the 95% UCL on the mean concentration or the maximum concentration.

Table A3-19
Summary Statistics and Derived 95% UCLs for Constituents of Potential Concern and Constituents of Potential Ecological Concern in Surface Water
Background

Constituent [a]	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/L)	Minimum Detected Concentration (mg/L)	Assumed Distribution	ProUCL 95% UCL [a] (mg/L)	EPC [b] (mg/L)
Aluminum, dissolved	21	5	23.8	0.410	0.0400	Kaplan-Meier	0.0990	0.0990
Arsenic, dissolved	13	6	46.2	0.00110	0.000500	Kaplan-Meier	0.000735	0.000735
Barium, dissolved	15	15	100	0.0850	0.0200	Gamma	0.0550	0.0550
Boron, dissolved	7	4	57.1	0.0200	0.0167	NA	NC	0.0200
Cadmium, dissolved	44	2	4.55	0.000100	0.000100	NA	NC	0.000100
Chromium, dissolved	37	14	37.8	0.00393	0.000200	Kaplan-Meier	0.000775	0.000775
Cobalt, dissolved	15	0	0	ND	ND	NA	NC	0.0100
Manganese, dissolved	20	20	100	0.0484	0.000600	Normal	0.0238	0.0238
Nickel, dissolved	41	35	85.4	0.00221	0.000400	Kaplan-Meier	0.00129	0.00129
Selenium, total	45	5	11.1	0.00100	0.000520	Kaplan-Meier	0.000579	0.000579
Thallium, dissolved	15	4	26.7	0.000150	0.000100	NA	NC	0.000150
Uranium, dissolved	29	25	86.2	0.00120	0.000200	Kaplan-Meier	0.000529	0.000529
Vanadium, dissolved	45	24	53.3	0.00620	0.000300	Kaplan-Meier	0.00140	0.00140
Zinc, dissolved	41	19	46.3	0.0150	0.00200	Kaplan-Meier	0.00525	0.00525

Notes:
% - percent
EPC - Exposure point concentration
mg/L - milligram per liter
NA - not applicable
NC - not calculated
UCL - Upper Confidence Limit

[a] Calculated using ProUCL version 4.1.00. If ProUCL 4.1.00 recommended the 97.5% or the 99% UCL, the recommended UCL was selected.
[b] The EPC is based on either the 95% UCL on the mean concentration or the maximum concentration. Cobalt was not detected in any background samples; the EPC shown is the maximum detection limit.

Table A3-20
Summary Statistics and Derived 95% UCLs for Constituents of Potential Concern and Constituents of Potential Ecological Concern in Sediment
Background

Constituent	Number of Samples	Number of Detections	Detection Frequency (%)	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Assumed Distribution	ProUCL 95% UCL [a] (mg/kg)	EPC [b] (mg/kg)
Antimony	4	2	50	5.00	4.80	NA	NC	5.00
Arsenic	4	4	100	4.55	2.10	NA	NC	4.55
Boron	4	4	100	8.40	6.20	NA	NC	8.40
Cadmium	13	13	100	3.74	0.220	Normal	2.29	2.29
Chromium	13	13	100	34.8	11.5	Normal	26.3	26.3
Copper	4	4	100	25.5	14.4	NA	NC	25.5
Manganese	4	4	100	405	194	NA	NC	405
Mercury	4	4	100	0.0380	0.0260	NA	NC	0.0380
Molybdenum	4	0	0	ND	ND	NA	NC	0.500
Nickel	13	13	100	24.4	5.80	Normal	19.7	19.7
Selenium	13	7	54	1.60	0.700	Kaplan-Meier	1.01	1.01
Silver	4	4	100	0.241	0.155	NA	NC	0.241
Thallium	4	4	100	0.378	0.171	NA	NC	0.378
Uranium	3	3	100	2.37	2.03	NA	NC	2.37
Vanadium	13	13	100	45.2	11.3	Normal	33.0	33.0
Zinc	13	13	100	151	18.0	Normal	107	107

Notes:

% - percent
EPC - Exposure point concentration
mg/kg - milligram per kilogram
NA - not applicable
NC - not calculated
ND - not detected
UCL - Upper Confidence Limit

[a] Calculated using ProUCL version 4.1.00. If ProUCL 4.1.00 recommended the 97.5% or the 99% UCL, the recommended UCL was selected.
[b] The EPC is based on either the 95% UCL on the mean concentration or the maximum concentration. Molybdenum was not detected in any background samples; the EPC shown is the maximum detection limit.

Table A3-21
Background Summary Statistics and Derived 95% UCLs for Constituents of Potential Concern in Groundwater Background

Constituent [a]	Number of Samples	Number of Detections[a]	Detection Frequency (%)	Maximum Detected Concentration (mg/L)	Minimum Detected Concentration (mg/L)	Assumed Distribution	ProUCL 95% UCL [a] (mg/L)	EPC [b] (mg/L)
Arsenic, total	8	5	62.5	0.000989	0.000266	Kaplan-Meier	0.000723	0.000723
Chromium, total	32	26	81.3	0.00524	0.000200	Kaplan-Meier	0.00232	0.00232
Cobalt, total	10	2	20.0	0.000436	0.000281	NA	NC	0.000436
Manganese, total	32	31	96.9	0.456	0.000600	Kaplan-Meier	0.189	0.189
Molybdenum, total	10	1	10.0	0.0239	0.0239	NA	NC	0.0239
Selenium, total	52	27	51.9	0.00267	0.000606	Kaplan-Meier	0.00124	0.00124
Thallium, total	10	2	20.0	0.000200	0.0000538	NA	NC	0.000200

Notes:

% - percent
EPC - Exposure point concentration
mg/L - milligram per liter
NA - not applicable
NC - not calculated
UCL - Upper Confidence Limit

[a] Calculated using ProUCL version 4.1.00. If ProUCL 4.1.00 recommended the 97.5% or the 99% UCL, the recommended UCL was selected.
[b] The EPC is based on either the 95% UCL on the mean concentration or the maximum concentration.

Table A3-22

Toxicity Values used in the Human Health Risk Assessment

Chemical of Potential Concern	CAS Number	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ Oral		Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ Dermal[b]		URF $(ug/m^3)^{-1}$ Inhalation		Chronic Reference Dose - RfD (mg/kg-d) Oral		Chronic Reference Dose - RfD (mg/kg-d) Dermal[b]		RfC (mg/m^3) Inhalation		ABS_{GI} [a] (%)	Critical Effect
Antimony	7440-36-0	na		na		na		4.0E-04	I	6.0E-05	R	na		15%	Longevity, blood glucose, and cholesterol
Arsenic	7440-38-2	1.5E+00	I	1.5E+00	R	4.3E-03	I	3.0E-04	I	3.0E-04	R	1.5E-05	C	95%	Dermal effects: Hyperpigmentation and keratosis
Cadmium, soil	7440-43-9	na		na		1.8E-03	I	1.0E-03	I	2.5E-05	R	1.0E-05	A	2.5%	Hematologic: proteinuria
Cadmium, water	7440-43-9	na		na		1.8E-03	I	5.0E-04	I	2.5E-05	R	1.0E-05	A	5%	Hematologic: proteinuria
Chromium	16065-83-1	na		na		na		1.5E+00	I	2.0E-02	R	na		1.3%	na
Cobalt	7440-48-4	na		na		9.0E-03	P	3.0E-04	P	3.0E-04	R	6.0E-06	P	100%	na
Manganese	7439-96-5	na		na		na		1.4E-01	I	5.6E-03	R	5.0E-05	I	4%	Neurological and neuro-behavioral effects
Molybdenum	7439-98-7	na		na		na		5.0E-03	I	5.0E-03	I	na		100%	Increased uric acid levels
Nickel	7440-02-0	na		na		2.6E-04	C	2.0E-02	I	8.0E-04	R	9.0E-05	A	4%	Decreased body and organ weights
Selenium	7782-49-2	na		na		na		5.0E-03	I	1.5E-03	R	2.0E-02	C	30%	Clinical selenosis
Thallium	7440-28-0	na		na		na		1.0E-05	P	1.0E-05	R	na		100%	Increased levels of SGOT and LDH
Uranium	7440-61-1	na		na		na		2.0E-04	I	2.0E-04	R	4.0E-05	A	100%	Body weight loss and moderate nephrotoxicity
Vanadium	7440-62-2	na		na		na		5.0E-03	U	1.3E-04	R	1.0E-04	A	2.6%	Decreased hair cystine
Zinc	7440-66-6	na		na		na		3.0E-01	I	3.0E-01	R	na		100%	Decrease in ESOD activity

Sources:

A Agency for Toxic Substances and Disease Registry (ATSDR) minimal risk levels as cited in USEPA's RSL Table (USEPA, 2015a)

I Integrated Risk Information System (IRIS) Database as cited in USEPA's RSL Table (USEPA, 2015a)

P Provisional Peer Reviewed Toxicity Values (PPRTVs) as cited in USEPA's RSL Table (USEPA, 2015a)

U United States Regional Screening Levels (RSLs) (USEPA, 2015a)

C CalEPA Toxicity Values as cited in USEPA's RSL Table (USEPA, 2015a)

R Route Extrapolation.

Notes:

ABS_{GI} - oral absorption efficiencies
CSF - cancer slope factor
IRIS - Integrated Risk Information System
mg/kg-d - milligram per kilogram per day
mg/m^3 - milligram per cubic meter
na - not available
RfD - reference dose
ug/m^3 - microgram per cubic meter
USEPA - U. S. Environmental Protection Agency
URF - unit risk factor
RfC - reference concentration

[a] Values are from USEPA RAGS Part E (USEPA 2004). Where no specific ABS_{GI} is available, the ABS_{GI} is assumed to be 100%.

[b] The following equations are used as recommended by the USEPA (2004) to estimate dermal CSF and RFDs from the ingestion toxicity values when ABS_{GI} is less than 50 percent: Dermal RFD = Oral RfD x ABS_{GI} and Dermal CSF = Oral SF/ABS_{GI}. When ABS_{GI} is greater than 50 percent, the dermal CSF and/or RfD is assumed to be equal to the oral CSF and/or RfD (USEPA, 2004).

Table A3-23
Summary of Tier I Henry Site Cumulative Risk Estimates for Current/Future Native Americans

Medium/Risk Driver[a]	EPC[b]				Current/Future Native American	
					ILCR	HI
Metals	**Upland Soil (mg/kg)**	**Riparian Soil (mg/kg)**	**Surface Water (mg/L)**	**Sediment (mg/kg)**		
Culturally Significant Plant - Upland Soil [c]					**2E-04**	**22**
Antimony	9.15	NA	NA	NA	NA	**2.2**
Arsenic	45.5	NA	NA	NA	**1.5E-04**	0.80
Cadmium	59.5	NA	NA	NA	NA	**9.8**
Cobalt	11.9	NA	NA	NA	NA	**3.0**
Selenium	318	NA	NA	NA	NA	**1.9**
Thallium	2.31	NA	NA	NA	NA	**1.7**
Culturally Significant Plant - Riparian Soil					**4E-04**	**57**
Antimony	NA	7.00	NA	NA	NA	**5.8**
Arsenic	NA	4.99	NA	NA	**3.9E-04**	**2.0**
Cadmium	NA	67.3	NA	NA	NA	**5.1**
Cobalt	NA	8.73	NA	NA	NA	**2.8**
Manganese	NA	1,080	NA	NA	NA	**3.1**
Nickel	NA	251	NA	NA	NA	**1.9**
Selenium	NA	45.0	NA	NA	NA	**23**
Thallium	NA	0.223	NA	NA	NA	**1.7**
Vanadium	NA	773	NA	NA	NA	**12**
Elk - Upland Soil and Surface Water					7E-07	0.1
Upland Soil					**9E-05**	**6**
Arsenic	45.5	NA	NA	NA	**8.5E-05**	0.44
Uranium	74.4	NA	NA	NA	NA	**1.2**
Vanadium	584	NA	NA	NA	NA	**2.1**
Riparian Soil					**9E-06**	**4**
Arsenic	NA	4.99	NA	NA	**9.4E-06**	0.049
Vanadium	NA	773	NA	NA	NA	**2.7**
Aquatic Plant - Surface Water and Sediment					**5E-04**	**82**
Antimony	NA	NA	0.00230	8.50	NA	**1.3**
Arsenic	NA	NA	0.0224	10.6	**4.6E-04**	**2.4**
Cadmium	NA	NA	0.0352	104	NA	**14**
Manganese	NA	NA	2.4	2,580	NA	**2.6**
Nickel	NA	NA	1.26	1,110	NA	**1.8**
Selenium	NA	NA	0.970	148	NA	**45**
Thallium	NA	NA	0.000348	2.17	NA	**1.5**
Uranium	NA	NA	NA	90.0	NA	**6.8**
Vanadium	NA	NA	0.0885	940	NA	**1.6**
Zinc	NA	NA	4.73	7,940	NA	**4.2**
Fish - Surface Water and Sediment [d]					**3E-05**	**13**
Antimony	NA	NA	ND	4.70	NA	**6.0**
Arsenic	NA	NA	0.000750	1.99	**2.8E-05**	0.14
Thallium	NA	NA	ND	0.122	NA	**6.2**
Surface Water					**4E-06**	0.7
Arsenic	NA	NA	0.0224	NA	**4.2E-06**	0.022
Radionuclides - Radium-226	**Upland Soil (pCi/g)**	**Riparian Soil (pCi/g)**	**Surface Water (pCi/L)**	**Sediment (pCi/g)**		
Culturally Significant Plants - Upland Soil	58.8	NA	NA	NA	**2.4E-03**	NA
Elk - Upland Soil	58.8	NA	NA	NA	1.0E-06	NA
Upland Soil	58.8	NA	NA	NA	**9.4E-04**	NA

Table A3-23
Summary of Tier I Henry Site Cumulative Risk Estimates for Current/Future Native Americans

Medium/Risk Driver[a]	EPC[b]				Current/Future Native American ILCR	Current/Future Native American HI
Aquatic Plant - Sediment	NA	NA	NA	62.6	**1.3E-03**	NA
Fish - Surface Water	NA	NA	0.720	NA	4.2E-07	NA
Cumulative Media ILCR/HI from Metals[e]:					**6E-04**	**101**
Cumulative Media ILCR from Radionuclides[f]:					**3E-03**	NA
Cumulative Media ILCR/HI from Metals and Radionuclides[e,f]:					**4E-03**	**101**
IDEQ Point of Departure:					10^{-5}	1
USEPA Risk Range:					10^{-6} - 10^{-4}	1

Notes:

[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented for risk drivers only. Risk estimates for all COPCs are presented in Attachment B.

[b] The EPC is based on the maximum detected concentration measured in various media collected from Henry Site sampling locations.

[c] Hazard estimates for antimony and thallium in culturally significant plants harvested from upland soil are based on the maximum detection limit for these analytes, as they were not detected in culturally significant plant tissue.

[d] The surface water and sediment EPCs for the fish consumption pathway is based on data from sample locations where fish are present or likely to be present.

[e] Cumulative media ILCR/HI for metals includes the higher of the ILCR/HI for culturally significant plants harvested from upland soil, riparian soil, or aquatic environments, and the higher of the ILCR/HI for upland soil or riparian soil direct contact.

[f] Cumulative media ILCR for radium-226 includes the higher of the ILCR for culturally significant plants harvested from upland soil or aquatic environments.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/L - milligram per liter
mg/kg - milligram per kilogram
NA - Not applicable
pCi/g - picoCuries per gram
pCi/L - picoCuries per liter

Table A3-24
Summary of Tier I Background Cumulative Risk Estimates for Current/Future Native Americans

Medium/Risk Driver[a]	EPC[b]				Current/Future Native American ILCR	Current/Future Native American HI
Metals	**Upland Soil (mg/kg)**	**Riparian Soil (mg/kg)**	**Surface Water (mg/L)**	**Sediment (mg/kg)**		
Culturally Significant Plant - Upland Soil [c]					**1E-03**	**77**
Antimony	3.60	NA	NA	NA	NA	**38**
Arsenic	19.0	NA	NA	NA	**1.5E-03**	**7.8**
Cadmium	44.0	NA	NA	NA	NA	**3.5**
Cobalt	13.3	NA	NA	NA	NA	**4.3**
Manganese	3,990	NA	NA	NA	NA	**11**
Nickel	230	NA	NA	NA	NA	**1.7**
Selenium	29.0	NA	NA	NA	NA	**1.1**
Thallium	1.30	NA	NA	NA	NA	**2.1**
Uranium	42.0	NA	NA	NA	NA	**1.4**
Vanadium	370	NA	NA	NA	NA	**5.7**
Culturally Significant Plant - Riparian Soil					**4E-04**	**19**
Antimony	NA	5.50	NA	NA	NA	**4.5**
Arsenic	NA	5.44	NA	NA	**4.3E-04**	**2.2**
Cadmium	NA	4.40	NA	NA	NA	**1.6**
Cobalt	NA	10.1	NA	NA	NA	**3.2**
Manganese	NA	1,080	NA	NA	NA	**3.1**
Thallium	NA	0.428	NA	NA	NA	**3.2**
Elk - Upland Soil and Surface Water					2E-07	0.04
Upland Soil					**4E-05**	**3**
Arsenic	19.0	NA	NA	NA	**3.6E-05**	0.18
Vanadium	370	NA	NA	NA	NA	**1.3**
Riparian Soil					**1E-05**	0.7
Arsenic	NA	5.44	NA	NA	**1.0E-05**	0.053
Aquatic Plant - Surface Water and Sediment					**2E-04**	**6**
Arsenic	NA	NA	0.00110	4.55	**2.0E-04**	1.0
Cadmium	NA	NA	0.000100	3.74	NA	**2.3**
Fish - Surface Water and Sediment					**4E-05**	**83**
Antimony	NA	NA	NA	5.00	NA	**6.4**
Arsenic	NA	NA	0.00110	4.55	**4E-05**	0.21
Thallium	NA	NA	0.000150	0.378	NA	**76**
Surface Water					2E-07	0.02
Radionuclides - Radium-226	**Upland Soil (pCi/g)**	**Riparian Soil (pCi/g)**	**Surface Water (pCi/L)**	**Sediment (pCi/g)**		
Culturally Significant Plants - Upland Soil	27.2	NA	NA	NA	**1.1E-03**	NA
Elk - Upland Soil	27.2	NA	NA	NA	4.8E-07	NA
Upland Soil	27.2	NA	NA	NA	**4.4E-04**	NA
Aquatic Plant - Sediment	NA	NA	NA	1.65	**3.5E-05**	NA
Fish - Surface Water	NA	NA	0.417	NA	2.4E-07	NA
Cumulative Media ILCR/HI from Metals[d]:					**2E-03**	**163**
Cumulative Media ILCR from Radionuclides[e]:					**2E-03**	NA
Cumulative Media ILCR/HI from Metals and Radionuclides[d,e]:					**3E-03**	**163**
IDEQ Point of Departure:					10^{-5}	1
USEPA Risk Range:					10^{-6} - 10^{-4}	1

Notes:

[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented for risk drivers only. Risk estimates for all COPCs are presented in Attachment C.

Table A3-24
Summary of Tier I Background Cumulative Risk Estimates for Current/Future Native Americans

Medium/Risk Driver[a]	EPC[b]	Current/Future Native American ILCR	Current/Future Native American HI

[b] The EPC is based on the maximum detected concentration measured in various media collected from background sampling locations.

[c] The hazard estimate for antimony in culturally significant plants harvested from upland soil is based on the maximum detection limit for antimony, as it was not detected in culturally significant plant tissue samples.

[d] Cumulative media ILCR/HI for metals includes the higher of the ILCR/HI for culturally significant plants harvested from upland soil, riparian soil, or aquatic environments, and the higher of the ILCR/HI for upland soil or riparian soil direct contact.

[e] Cumulative media ILCR for radium-226 includes the higher of the ILCR for culturally significant plants harvested from upland soil or aquatic environments.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/L - milligram per liter
mg/kg - milligram per kilogram
NA - Not applicable
pCi/g - picoCuries per gram
pCi/L - picoCuries per liter
USEPA - U. S. Environmental Protection Agency

Table A3-25
Summary of Tier I Henry Site Cumulative Risk Estimates for Hypothetical Future Residents

Medium/Risk Driver[a]	EPC[b]					Hypothetical Future Resident	
						ILCR	HI
Metals	**Upland Soil (mg/kg)**	**Riparian Soil (mg/kg)**	**Surface Water (mg/L)**	**Sediment (mg/kg)**	**Groundwater (mg/L)**		
Fruits and Vegetables - Upland Soil and Groundwater						**1E-02**	**319**
Antimony	9.15	NA	NA	NA	NA	NA	**2.3**
Arsenic	45.5	NA	NA	NA	0.00430	**1.2E-02**	**60**
Cadmium	59.5	NA	NA	NA	NA	NA	**9.4**
Cobalt	11.9	NA	NA	NA	0.0100	NA	**2.5**
Manganese	2,040	NA	NA	NA	3.39	NA	**1.5**
Molybdenum	NA	NA	NA	NA	0.110	NA	**45**
Nickel	425	NA	NA	NA	NA	NA	**1.5**
Selenium	318	NA	NA	NA	0.219	NA	**53**
Thallium	2.31	NA	NA	NA	0.000900	NA	**128**
Uranium	74.4	NA	NA	NA	NA	NA	**11**
Vanadium	584	NA	NA	NA	NA	NA	**4.6**
Upland Soil						**9E-05**	**6**
Arsenic	45.5	NA	NA	NA	NA	**8.5E-05**	0.44
Uranium	74.4	NA	NA	NA	NA	NA	**1.2**
Vanadium	584	NA	NA	NA	NA	NA	**2.1**
Riparian Soil						8E-07	0.3
Fish - Surface Water and Sediment [c]						**3E-05**	**13**
Antimony	NA	NA	ND	4.70	NA	NA	**6.0**
Arsenic	NA	NA	0.000750	1.99	NA	**2.8E-05**	0.14
Thallium	NA	NA	ND	0.122	NA	NA	**6.2**
Surface Water						6E-07	0.1
Groundwater						**1E-04**	**10**
Arsenic	NA	NA	NA	NA	0.00430	**1.1E-04**	0.59
Cobalt	NA	NA	NA	NA	0.0100	NA	**1.4**
Manganese	NA	NA	NA	NA	3.39	NA	**1.1**
Selenium	NA	NA	NA	NA	0.219	NA	**1.8**
Thallium	NA	NA	NA	NA	0.000900	NA	**3.7**
Radionuclides - Radium-226	**Upland Soil (pCi/g)**	**Riparian Soil (pCi/g)**	**Surface Water (pCi/L)**	**Sediment (pCi/g)**	**Groundwater (pCi/L)**		
Fruits and Vegetables - Upland Soil	58.8	NA	NA	NA	NA	**2.4E-03**	NA
Upland Soil	58.8	NA	NA	NA	NA	**9.4E-04**	NA
Fish - Surface Water	NA	NA	0.720	NA	NA	4.2E-07	NA
Radionuclides - Radom-222 [d]	**Upland Soil (pCi/m^3)**						
Indoor Air	13,327					**5.5E-02**	NA
Cumulative Media ILCR/HI for Metals[e]:						**1E-02**	**348**
Cumulative Media ILCR for Radionuclides:						**6E-02**	NA
Cumulative Media ILCR/HI from Metals and Radionuclides[e]:						**7E-02**	**348**
IDEQ Point of Departure:						10^{-5}	1
USEPA Risk Range:						10^{-6} - 10^{-4}	1

Notes:

[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented for risk drivers only. Risk estimates for all COPCs are presented in Attachment B.

[b] The EPC is based on the maximum detected concentration measured in various media collected from Henry Site sampling locations.

[c] The surface water and sediment EPCs for the fish consumption pathway is based on data from sample locations where fish are present or likely to be present.

Table A3-25 Summary of Tier I Henry Site Cumulative Risk Estimates for Hypothetical Future Residents			
		Hypothetical Future Resident	
Medium/Risk Driver[a]	**EPC[b]**	**ILCR**	**HI**

[d] The radon-222 concentration in indoor air was calculated from radon flux measurements made in background upland soil, and is in units of picoCuries per cubic meter (pCi/m^3).

[e] Cumulative media ILCR/HI for metals includes the higher of the ILCR/HI for upland soil or riparian soil direct contact.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/L - milligram per liter
mg/kg - milligram per kilogram
NA - Not applicable
USEPA - U. S. Environmental Protection Agency
pCi/g - picoCuries per gram
pCi/L - picoCuries per liter
pCi/m^3 - picoCuries per cubic meter

Table A3-26
Summary of Tier I Background Cumulative Risk Estimates for Hypothetical Future Residents

Medium/Risk Driver[a]	EPC[b]					Hypothetical Future Resident ILCR	Hypothetical Future Resident HI
Metals	**Upland Soil (mg/kg)**	**Riparian Soil (mg/kg)**	**Surface Water (mg/L)**	**Sediment (mg/kg)**	**Groundwater (mg/L)**		
Fruits and Vegetables - Upland Soil and Groundwater						**2E-03**	**70**
Antimony	3.60	NA	NA	NA	NA	NA	**24**
Arsenic	19.0	NA	NA	NA	0.000989	**1.5E-03**	**7.8**
Cadmium	44.0	NA	NA	NA	NA	NA	**2.8**
Cobalt	13.3	NA	NA	NA	0.000436	NA	**4.3**
Manganese	3,990	NA	NA	NA	0.456	NA	**11**
Molybdenum	NA	NA	NA	NA	0.0239	NA	**3.3**
Nickel	230	NA	NA	NA	NA	NA	**1.7**
Selenium	29.0	NA	NA	NA	0.00267	NA	**2.6**
Thallium	1.30	NA	NA	NA	0.000200	NA	**5.0**
Vanadium	370	NA	NA	NA	NA	NA	**5.7**
Upland Soil						**4E-05**	**3**
Arsenic	19.0	NA	NA	NA	NA	**3.6E-05**	0.18
Vanadium	370	NA	NA	NA	NA	NA	**1.3**
Riparian Soil						8E-07	0.06
Fish - Surface Water and Sediment						**4E-05**	**83**
Antimony	NA	NA	NA	5.00	NA	NA	**6.4**
Arsenic	NA	NA	0.00110	4.55	NA	**4E-05**	0.21
Thallium	NA	NA	0.000150	0.378	NA	NA	**76**
Surface Water						3E-08	0.003
Groundwater						**3E-05**	1
Arsenic	NA	NA	NA	NA	0.000989	**2.6E-05**	0.14
Radionuclides - Radium-226	**Upland Soil (pCi/g)**	**Riparian Soil (pCi/g)**	**Surface Water (pCi/L)**	**Sediment (pCi/g)**	**Groundwater (pCi/L)**		
Fruits and Vegetables - Upland Soil	27.2	NA	NA	NA	NA	**1.1E-03**	NA
Upland Soil	27.2	NA	NA	NA	NA	**4.4E-04**	NA
Fish - Surface Water	NA	NA	0.417	NA	NA	2.4E-07	NA
Radionuclides - Radom-222 [c]	**Indoor Air (pCi/m^3)**						
Indoor Air	12,684					**5.2E-02**	NA
Cumulative Media ILCR/HI from Metals[d]:						**2E-03**	**157**
Cumulative Media ILCR from Radionuclides:						**5E-02**	NA
Cumulative Media ILCR/HI from Metals and Radionuclides[d]:						**6E-02**	**157**
IDEQ Point of Departure:						10^{-5}	1
USEPA Risk Range:						10^{-6} - 10^{-4}	1

Notes:
[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented if the COPC is a risk driver only. Risk estimates for all COPCs are presented in Attachment C.
[b] The EPC is based on the maximum detected concentration measured in various media collected from background sampling locations.
[c] The radon-222 concentration in indoor air was calculated from radon flux measurements made in background upland soil, and is in units of picoCuries per cubic meter (pCi/m^3).
[d] Cumulative media ILCR/HI for metals includes the higher of the ILCR/HI for upland soil or riparian soil direct contact.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/L - milligram per liter
mg/kg - milligram per kilogram
NA - Not applicable
pCi/g - picoCuries per gram
pCi/L - picoCuries per liter
pCi/m^3 - picoCuries per cubic meter
USEPA - U. S. Environmental Protection Agency

Table A3-27
Summary of Tier I Henry Site Cumulative Risk Estimates for Current/Future Seasonal Ranchers

Medium/Risk Driver[a]	**EPC[b]**			**Current/Future Seasonal Rancher**	
				ILCR	**HI**
Metals	**Upland Soil (mg/kg)**	**Surface Water (mg/L)**	**Groundwater (mg/L)**		
Cattle - Upland Soil and Surface Water				**9E-05**	**15**
Arsenic	45.5	0.0224	NA	**9.4E-05**	0.61
Cobalt	11.9	0.0141	NA	NA	**1.4**
Selenium	318	0.970	NA	NA	**2.4**
Thallium	2.31	0.000348	NA	NA	**9.1**
Cattle - Upland Soil and Groundwater				**9E-05**	**15**
Arsenic	45.5	NA	0.00430	**8.8E-05**	0.57
Cobalt	11.9	NA	0.0100	NA	**1.3**
Selenium	318	NA	0.219	NA	**1.6**
Thallium	2.31	NA	0.000900	NA	**9.9**
Upland Soil				**1E-05**	1
Arsenic	45.5	NA	NA	**1.5E-05**	0.094
Groundwater				**2E-05**	0.1
Arsenic	NA	NA	0.00430	**2.1E-05**	0.0065
Radionuclides - Radium-226	**Upland Soil (pCi/g)**	**Surface Water (pCi/L)**	**Groundwater (pCi/L)**		
Cattle - Upland Soil	58.8	NA	NA	**9.3E-05**	NA
Upland Soil	58.8	NA	NA	**1.9E-03**	NA
Cumulative Media ILCR/HI from Metals[c]:				**1E-04**	**16**
Cumulative Media ILCR from Radionuclides:				**2E-03**	NA
Cumulative Media ILCR/HI from Metals and Radionuclides[c]:				**2E-03**	**16**
IDEQ Point of Departure:				10^{-5}	1
USEPA Risk Range:				10^{-6} - 10^{-4}	1

Notes:

[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented for risk drivers only. Risk estimates for all COPCs are presented in Attachment B.

[b] The EPC is based on the maximum detected concentration measured in various media collected from Henry Site sampling locations.

[c] Cumulative media ILCR/HI for metals includes the higher of the ILCR/HI for consumption of cattle that have ingested surface water or groundwater. Surface water and ground water ingestion by cattle were not evaluated for radium-226 because uranium, and therefore radium-226, was not identified as a chemical of potential concern for these media.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/L - milligram per liter
mg/kg - milligram per kilogram
NA - Not applicable
USEPA - U. S. Environmental Protection Agency
pCi/g - picoCuries per gram
pCi/L - picoCuries per liter

Table A3-28
Summary of Tier I Background Cumulative Risk Estimates for Current/Future Seasonal Ranchers

Medium/Risk Driver[a]	**EPC**[b]			**Current/Future Seasonal Rancher**	
				ILCR	**HI**
Metals	**Upland Soil (mg/kg)**	**Surface Water (mg/L)**	**Groundwater (mg/L)**		
Cattle - Upland Soil and Surface Water				**4E-05**	**8**
Arsenic	19.0	0.00110	NA	**3.6E-05**	0.24
Cobalt	13.3	0.0100	NA	NA	**1.4**
Thallium	1.30	0.000150	NA	NA	**5.1**
Cattle - Upland Soil and Groundwater				**4E-05**	**8**
Arsenic	19.0	NA	0.000989	**3.6E-05**	0.24
Cobalt	13.3	NA	0.000436	NA	**1.2**
Thallium	1.30	NA	0.000200	NA	**5.1**
Upland Soil				**6E-06**	0.8
Arsenic	19.0	NA	NA	**6.1E-06**	0.039
Groundwater				**5E-06**	0.02
Arsenic	NA	NA	0.000989	**4.8E-06**	0.0015
Radionuclides - Radium-226	**Upland Soil (pCi/g)**	**Surface Water (pCi/L)**	**Groundwater (pCi/L)**		
Cattle - Upland Soil	27.2	NA	NA	**4.3E-05**	NA
Upland Soil	27.2	NA	NA	**9.0E-04**	NA
Cumulative Media ILCR/HI from Metals[c]**:**				**5E-05**	**9**
Cumulative Media ILCR from Radionuclides:				**9E-04**	NA
Cumulative Media ILCR/HI from Metals and Radionuclides[c]**:**				**1E-03**	**9**
IDEQ Point of Departure:				10^{-5}	1
USEPA Risk Range:				10^{-6} - 10^{-4}	1

Notes:

[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented for risk drivers only. Risk estimates for all COPCs are presented in Attachment C.

[b] The EPC is based on the maximum detected concentration measured in various media collected from background sampling locations.

[c] Cumulative media ILCR/HI for metals includes the higher of the ILCR/HI for consumption of cattle that have ingested surface water or groundwater. Surface water and ground water ingestion by cattle were not evaluated for radium-226 because uranium, and therefore radium-226, was not identified as a chemical of potential concern for these media.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/kg - milligram per kilogram
mg/L - milligram per liter
NA - Not applicable
USEPA - U. S. Environmental Protection Agency
pCi/g - picoCuries per gram
pCi/L - picoCuries per liter

Table A3-29
Summary of Refined Human Health Constituent of Potential Concern to be Evaluated in Tier II Baseline Risk Assessment
Henry Site

COPCs	Direct Exposure				Indirect Exposure [a]							
	Upland Soil	Riparian Soil	Surface Water	Ground-water	Upland Culturally Significant Plant	Riparian Culturally Significant Plant	Aquatic Culturally Significant Plant	Fruits and Vegetables	Elk	Cattle - Surface Water	Cattle - Ground-water	Fish
Antimony	X	X			**X**	**X**	**X**	**X**	X	X	X	**X**
Arsenic	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	X	**X**	**X**	**X**
Cadmium	X	X	X		**X**	**X**	X	**X**	X	X	X	X
Chromium			X	X				X	X	X	X	X
Cobalt	X	X	X	**X**	**X**	**X**	X	**X**	X	**X**	**X**	X
Manganese	X	X	X	**X**	X	**X**	**X**	**X**	X	X	X	X
Molybdenum				X				**X**			X	
Nickel	X	X	X		X	**X**	**X**	**X**	X	X	X	X
Radium-226	**X**				**X**		**X**	**X**	X	**X**	**X**	X
Radon-222 [b]	**X**											
Selenium	X	X	X	**X**	**X**	**X**	**X**	**X**	X	**X**	**X**	X
Thallium	X	X	X	**X**	**X**	**X**	**X**	**X**	X	**X**	**X**	**X**
Uranium	X				X		**X**	**X**	X	X	X	X
Vanadium	**X**	**X**	X		X	**X**	**X**	**X**	X	X	X	X
Zinc							**X**					X

Notes:

[a] All media-specific COPCs were evaluated for the indirect pathways indicated in Figure 6-1 in addition to direct exposure pathways (i.e., ingestion, inhalation, and dermal contact) except sediment COPCs, which were evaluated through the indirect uptake to aquatic culturally significant plant pathway only.

[b] Radon-222 was evaluated for indoor air exposure only; receptors are not directly exposed to radon-222 in upland soil.

[c] COPCs further evaluated in the Tier II Baseline Risk Assessment are those with a chemical-specific ILCR or HQ exceeding 1×10^{-6} or 1, respectively, in the Tier I Baseline Risk Assessment.

X - constituent of potential concern
X - Tier I constituent of potential concern [c]

COPC - constituent of potential concern
ILCR - incremental lifetime cancer risk
HQ - hazard quotient

Table A3-30
Summary of Tier II CTE Henry Site Cumulative Risk Estimates for Current/Future Native Americans

Medium/Risk Driver[a]	EPC[b]				Current/Future Native American	
					ILCR	**HI**
Metals	**Upland Soil (mg/kg)**	**Riparian Soil (mg/kg)**	**Surface Water (mg/L)**	**Sediment (mg/kg)**		
Culturally Significant Plant - Upland Soil [c]					**8E-06**	**3**
Arsenic	24.9	NA	NA	NA	**7.9E-06**	0.15
Cadmium	32.5	NA	NA	NA	NA	**1.7**
Culturally Significant Plant - Riparian Soil					**2E-05**	**4**
Arsenic	NA	4.25	NA	NA	**1.7E-05**	0.34
Elk - Upland Soil and Surface Water					NA	NA
Upland Soil					**3E-06**	0.3
Arsenic	24.9	NA	NA	NA	**2.8E-06**	0.054
Riparian Soil					5E-07	0.07
Aquatic Plant - Surface Water and Sediment					**2E-05**	**6**
Arsenic	NA	NA	0.00928	7.49	**1.7E-05**	0.32
Cadmium	NA	NA	0.00371	27.1	NA	1.3
Selenium	NA	NA	0.102	49.8	NA	**2.6**
Fish - Surface Water and Sediment [d]					9E-07	1
Surface Water					7E-08	0.001
Radionuclides - Radium-226	**Upland Soil (pCi/g)**	**Riparian Soil (pCi/g)**	**Surface Water (pCi/L)**	**Sediment (pCi/g)**		
Culturally Significant Plant - Upland Soil	12.6	NA	NA	NA	**2.6E-05**	NA
Elk - Upland Soil	12.6	NA	NA	NA	NA	NA
Upland Soil	12.6	NA	NA	NA	**1.8E-05**	NA
Aquatic Plant - Sediment	NA	NA	NA	21.3	**2.3E-05**	NA
Fish - Surface Water	NA	NA	0.578	NA	NA	NA
Cumulative Media ILCR/HI for Metals[e]:					**2E-05**	**7**
Cumulative Media ILCR for Radionuclides[f]:					**4E-05**	NA
Cumulative Media ILCR/HI for Metals and Radionuclides[e,f]:					**7E-05**	**7**
IDEQ Point of Departure:					10^{-5}	1
USEPA Risk Range:					10^{-6} - 10^{-4}	1

Notes:

[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented for risk drivers only. Risk estimates for all COPCs are presented in Attachment D.

[b] The EPC is either the 95% UCL on the mean concentration or the maximum detected concentration detected in samples from Henry Site sampling locations.

[c] Hazard estimates for antimony and thallium in culturally significant plants harvested from upland soil are based on the maximum detection limit for these analytes, as they were not detected in culturally significant plant tissue. Note that the hazard estimates for antimony and thallium in culturally significant plants are included in the cumulative hazard estimate but is not shown in this table, as they did not exceed 1.

[d] Risk and hazard associated with the fish consumption pathway were based on surface water and sediment data from sample locations where fish are present or likely to be present.

[e] Cumulative media for metals ILCR/HI includes the higher of the ILCR/HI for culturally significant plants harvested from upland soil, riparian soil, or aquatic environments, and the higher of the ILCR/HI for upland soil or riparian soil direct contact.

[f] Cumulative media ILCR for radium-226 includes the higher of the ILCR for culturally significant plants harvested from upland soil or aquatic environments.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

Table A3-30 Summary of Tier II CTE Henry Site Cumulative Risk Estimates for Current/Future Native Americans			
		Current/Future Native American	
Medium/Risk Driver[a]	EPC[b]	ILCR	HI

CTE - central tendency estimate
EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/L - milligram per liter
mg/kg - milligram per kilogram
NA - Not applicable
pCi/g - picoCuries per gram
pCi/L - picoCuries per liter
USEPA - U. S. Environmental Protection Agency

Table A3-31
Summary of Tier II CTE Henry Site Cumulative Risk Estimates for Hypothetical Future Residents

Medium/Risk Driver[a]	**EPC**[b]					**Hypothetical Future Resident ILCR**	**Hypothetical Future Resident HI**
Metals	**Upland Soil (mg/kg)**	**Riparian Soil (mg/kg)**	**Surface Water (mg/L)**	**Sediment (mg/kg)**	**Groundwater (mg/L)**		
Fruits and Vegetables - Upland Soil and Groundwater						**1E-04**	**4**
Arsenic	24.9	NA	NA	NA	0.00227	**1.0E-04**	0.52
Thallium	1.31	NA	NA	NA	0.000505	NA	**2.3**
Upland Soil						**3E-06**	0.1
Arsenic	24.9	NA	NA	NA	NA	**2.8E-06**	0.054
Riparian Soil						NA	NA
Fish - Surface Water and Sediment [c]						9E-07	1
Surface Water						NA	NA
Groundwater						**6E-06**	**2**
Arsenic	NA	NA	NA	NA	0.00227	**5.5E-06**	0.11
Radionuclides - Radium-226	**Upland Soil (pCi/g)**	**Riparian Soil (pCi/g)**	**Surface Water (pCi/L)**	**Sediment (pCi/g)**	**Groundwater (pCi/L)**		
Fruits and Vegetables - Upland Soil	12.6	NA	NA	NA	NA	**2.6E-05**	NA
Upland Soil	12.6	NA	NA	NA	NA	**1.8E-05**	NA
Fish - Surface Water	NA	NA	0.58	NA	NA	0.0E+00	NA
Radionuclides - Radom-222 [d]	**Indoor Air (pCi/m^3)**						
Indoor Air	8,084					**8.9E-03**	NA
Cumulative Media ILCR/HI for Metals[e]**:**						**1E-04**	**7**
Cumulative Media ILCR for Radionuclides:						**9E-03**	NA
Cumulative Media ILCR/HI from Metals and Radionuclides[e]**:**						**9E-03**	**7**
IDEQ Point of Departure:						10^{-5}	1
USEPA Risk Range:						10^{-6} - 10^{-4}	1

Notes:

[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented for risk drivers only. Risk estimates for all COPCs are presented in Attachment D.

[b] The EPC is based on either the 95% UCL on the mean concentration or the maximum detected concentration or the in samples from Henry Site sampling locations.

[c] Risk and hazard associated with the fish consumption pathway were based on surface water and sediment data from sample locations where fish are present or likely to be present.

[d] The radon-222 concentration in indoor air was calculated from radon flux measurements made in background upland soil, and is in units of picoCuries per cubic meter (pCi/m^3).

[e] Cumulative media ILCR/HI for metals includes the higher of the ILCR/HI for upland soil or riparian soil direct contact.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

CTE - central tendency estimate
EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/L - milligram per liter
mg/kg - milligram per kilogram
NA - Not applicable
pCi/g - picoCuries per gram
pCi/L - picoCuries per liter
pCi/m^3 - picoCuries per cubic meter
UCL - upper confidence limit
USEPA - U. S. Environmental Protection Agency

Table A3-32
Summary of Tier II CTE Henry Site Cumulative Risk Estimates for Current/Future Seasonal Ranchers

Medium/Risk Driver[a]	**EPC**[b]			**Current/Future Seasonal Rancher**	
				ILCR	**HI**
Metals	**Upland Soil (mg/kg)**	**Surface Water (mg/L)**	**Groundwater (mg/L)**		
Cattle - Upland Soil and Surface Water				**4E-06**	**2**
Arsenic	24.9	0.00928	NA	**3.5E-06**	0.086
Thallium	1.31	0.0000813	NA	NA	**1.3**
Cattle - Upland Soil and Groundwater				**3E-06**	**2**
Arsenic	24.9	NA	0.00227	**3.3E-06**	0.081
Thallium	1.31	NA	0.000505	NA	**1.5**
Upland Soil				6E-07	0.09
Groundwater				1E-06	0.06
Radionuclides - Radium-226	**Upland Soil (pCi/g)**	**Surface Water (pCi/L)**	**Groundwater (pCi/L)**		
Cattle - Upland Soil	12.6	NA	NA	1.4E-06	NA
Upland Soil	12.6	NA	NA	**2.8E-05**	NA
Cumulative Media ILCR/HI from Metals[c]**:**				**5E-06**	**2**
Cumulative Media ILCR from Radionuclides:				**3E-05**	NA
Cumulative Media ILCR/HI from Metals and Radionuclides[c]**:**				**3E-05**	**2**
IDEQ Point of Departure:				10^{-5}	1
USEPA Risk Range:				10^{-6} - 10^{-4}	1

Notes:

[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented for risk drivers only. Risk estimates for all COPCs are presented in Attachment D.

[b] The EPC is either the 95% UCL on the mean concentration or the maximum detected concentration detected in samples from Henry Site sampling locations.

[c] Cumulative media ILCR/HI for metals includes the higher of the ILCR/HI for consumption of cattle that have ingested surface water or groundwater. Surface water and ground water ingestion by cattle were not evaluated for radium-226 because uranium, and therefore radium-226, was not identified as a chemical of potential concern for these media.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

CTE - central tendency estimate
EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/L - milligram per liter
mg/kg - milligram per kilogram
NA - Not applicable
pCi/g - picoCuries per gram
pCi/L - picoCuries per liter
USEPA - U. S. Environmental Protection Agency

Table A3-33
Summary of Tier II CTE Henry Site Cumulative Risk Estimates for Current/Future Recreational Hunters

Medium/Risk Driver[a]	EPC[b]		Current/Future Recreational Hunter ILCR	Current/Future Recreational Hunter HI
Metals	**Upland Soil (mg/kg)**	**Surface Water (mg/L)**		
Elk - Upland Soil and Surface Water			NA	NA
Upland Soil			5E-08	0.008
Radionuclides - Radium-226	**Upland Soil (pCi/g)**	**Surface Water (pCi/L)**		
Elk - Upland Soil	12.6	NA	NA	NA
Upland Soil	12.6	NA	**7.4E-06**	NA
Cumulative Media ILCR/HI from Metals:			5E-08	0.008
Cumulative Media ILCR from Radionuclides:			**7E-06**	NA
Cumulative Media ILCR/HI from Metals and Radionuclides:			**7E-06**	0.008
IDEQ Point of Departure:			10^{-5}	1
USEPA Risk Range:			10^{-6} - 10^{-4}	1

Notes:

[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented for risk drivers only. Risk estimates for all COPCs are presented in Attachment D.

[b] The EPC is either the 95% UCL on the mean concentration or the maximum detected concentration detected in samples from Henry Site sampling locations.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

CTE - central tendency estimate
EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/kg - milligram per kilogram
NA - Not applicable
pCi/g - picoCuries per gram
pCi/L - picoCuries per liter
USEPA - U. S. Environmental Protection Agency

Table A3-34
Summary of Tier II CTE Henry Site Cumulative Risk Estimates for Current/Future Recreational Camper / Hikers

Medium/Risk Driver[a]	EPC[b]	Current/Future Recreational Camper/Hiker ILCR	Current/Future Recreational Camper/Hiker HI
Metals	**Upland Soil (mg/kg)**		
Upland Soil		4E-08	0.005
Radionuclides - Radium-226	**Upland Soil (pCi/g)**		
Upland Soil	12.6	**3.5E-06**	NA
Cumulative Media ILCR/HI from Metals:		4E-08	0.005
Cumulative Media ILCR from Radionuclides:		**3E-06**	NA
Cumulative Media ILCR/HI from Metals and Radionuclides:		**4E-06**	0.005
IDEQ Point of Departure:		10^{-5}	1
USEPA Risk Range:		10^{-6} - 10^{-4}	1

Notes:

[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented for risk drivers only. Risk estimates for all COPCs are presented in Attachment D.

[b] The EPC is either the 95% UCL on the mean concentration or the maximum detected concentration detected in samples from Henry Site sampling locations.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

CTE - central tendency estimate
EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/kg - milligram per kilogram
NA - Not applicable
pCi/g - picoCuries per gram
USEPA - U. S. Environmental Protection Agency

Table A3-35 Summary of Tier II CTE Henry Site Cumulative Risk Estimates for Current/Future Recreational Fishers					
Medium/Risk Driver[a]	**EPC[b]**			**Current/Future Recreational Fisher**	
				ILCR	**HI**
Metals	**Riparian Soil (mg/kg)**	**Surface Water (mg/L)**	**Sediment (mg/kg)**		
Riparian Soil				NA	NA
Fish - Surface Water and Sediment [c]				9E-07	1
Surface Water				NA	NA
Cumulative Media ILCR/HI from Metals[c]:				9E-07	1
IDEQ Point of Departure:				10^{-5}	1
USEPA Risk Range:				10^{-6} - 10^{-4}	1

Notes:

[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented for risk drivers only. Risk estimates for all COPCs are presented in Attachment D.

[b] The EPC is based on either the 95% UCL on the mean concentration or the maximum detected concentration in samples from Henry Site sampling locations.

[c] Risk and hazard associated with the fish consumption pathway were based on surface water and sediment data from sample locations where fish are present or likely to be present.

[d] Cumulative Media ILCR is calculated based on exposure to metals only, as risks associated with exposure to radium-226 was de minimus in the Tier II risk assessment and therefore not carried in to the Tier II risk assessment.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

CTE - central tendency estimate
EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/L - milligram per liter
mg/kg - milligram per kilogram
NA - Not applicable
pCi/g - picoCuries per gram
pCi/L - picoCuries per liter
USEPA - U. S. Environmental Protection Agency

Table A3-36
Summary of Tier II RME Henry Site Cumulative Incremental Risk Estimates for Current/Future Native Americans

Medium/Risk Driver[a]	EPC[b]				Current/Future Native American					
					Site-Related		Background		Incremental	
					ILCR	HI	ILCR	HI	ILCR	HI
Metals	**Upland Soil (mg/kg)**	**Riparian Soil (mg/kg)**	**Surface Water (mg/L)**	**Sediment (mg/kg)**						
Culturally Significant Plant - Upland Soil [c]					**2E-04**	**18**	**6E-04**	**56**	0E+00	**2**
Antimony	4.81	NA	NA	NA	NA	**2.2**	NA	**38**	NA	0
Arsenic	24.9	NA	NA	NA	**1.5E-04**	0.80	**6.5E-04**	**3.3**	0E+00	0
Cadmium	32.5	NA	NA	NA	NA	**9.0**	NA	**9.8**	NA	0
Cobalt	7.74	NA	NA	NA	NA	**3.0**	NA	**2.5**	NA	0.42
Selenium	46.4	NA	NA	NA	NA	**1.3**	NA	0.17	NA	**1.2**
Thallium	1.31	NA	NA	NA	NA	**1.7**	NA	**2.1**	NA	0
Culturally Significant Plant - Riparian Soil					**3E-04**	**21**	**3E-04**	**15**	0E+00	**7**
Antimony	NA	6.17	NA	NA	NA	**5.1**	NA	**4.5**	NA	0.55
Arsenic	NA	4.25	NA	NA	**3.3E-04**	**1.7**	**3.5E-04**	**1.8**	0E+00	0
Cadmium	NA	7.38	NA	NA	NA	**1.2**	NA	0.98	NA	0.25
Cobalt	NA	7.98	NA	NA	NA	**2.6**	NA	**2.7**	NA	0
Manganese	NA	901	NA	NA	NA	**2.5**	NA	**1.8**	NA	0.70
Selenium	NA	14.9	NA	NA	NA	**3.1**	NA	0.28	NA	**2.8**
Thallium	NA	0.200	NA	NA	NA	**1.5**	NA	**2.5**	NA	0
Vanadium	NA	165	NA	NA	NA	**2.6**	NA	0.57	NA	**2.0**
Elk - Upland Soil and Surface Water					NA	NA	NA	NA	NA	NA
Upland Soil					**5E-05**	**2**	**2E-05**	0.6	**3E-05**	1.1
Arsenic	24.9	NA	NA	NA	**4.7E-05**	0.24	**1.5E-05**	0.080	**3.1E-05**	0.16
Riparian Soil					**8E-06**	0.6	**8E-06**	0.2	0E+00	0.4
Arsenic	NA	4.25	NA	NA	**8.0E-06**	0.041	**8.3E-06**	0.043	0E+00	0
Aquatic Plant - Surface Water and Sediment					**3E-04**	**30**	**2E-04**	**5**	**1E-04**	**24**
Arsenic	NA	NA	0.00928	7.49	**3.2E-04**	**1.7**	**2.0E-04**	1.0	**1.3E-04**	0.65
Cadmium	NA	NA	0.00371	27.1	NA	**6.7**	NA	**1.7**	NA	**5.0**
Manganese	NA	NA	1.17	1,130	NA	**1.1**	NA	0.41	NA	0.73
Selenium	NA	NA	0.102	49.8	NA	**14**	NA	0.18	NA	**13**
Uranium	NA	NA	0.00586	30.6	NA	**2.3**	NA	0.18	NA	**2.1**
Zinc	NA	NA	0.484	1,385	NA	**1.6**	NA	0.38	NA	**1.2**
Fish - Surface Water and Sediment [d]					**3E-05**	**12**	**3E-05**	**83**	6E-07	0.003
Antimony	NA	NA	ND	4.70	NA	**6.0**	NA	**6.4**	NA	0
Arsenic	NA	NA	0.000750	1.99	**2.8E-05**	0.14	**2.7E-05**	0.14	5.6E-07	0.0029
Thallium	NA	NA	ND	0.122	NA	**6.2**	NA	**76**	NA	0

Table A3-36
Summary of Tier II RME Henry Site Cumulative Incremental Risk Estimates for Current/Future Native Americans

Medium/Risk Driver[a]	EPC[b]				Current/Future Native American					
					Site-Related		Background		Incremental	
					ILCR	HI	ILCR	HI	ILCR	HI
Surface Water					**2E-06**	0.009	1E-07	0.0007	**2E-06**	0.008
Arsenic	NA	NA	0.008942	NA	**1.7E-06**	0.0089	1.4E-07	0.00071	**1.6E-06**	0.0082
Radionuclides - Radium-226	**Upland Soil (pCi/g)**	**Riparian Soil (pCi/g)**	**Surface Water (pCi/L)**	**Sediment (pCi/g)**						
Culturally Significant Plant - Upland Soil	12.6	NA	NA	NA	**5.1E-04**	NA	**1.9E-04**	NA	**3.1E-04**	NA
Elk - Upland Soil	12.6	NA	NA	NA	NA	NA	NA	NA	NA	NA
Upland Soil	12.6	NA	NA	NA	**2.0E-04**	NA	**7.7E-05**	NA	**1.2E-04**	NA
Aquatic Plant - Sediment	NA	NA	NA	21.3	**4.5E-04**	NA	**3.5E-05**	NA	**4.1E-04**	NA
Fish - Surface Water	NA	NA	0.578	NA	NA	NA	NA	NA	NA	NA
Cumulative Media ILCR/HI from Metals[e]:					**4E-04**	**44**	**7E-04**	**139**	**2E-04**	**26**
Cumulative Media ILCR from Radionuclides[f]:					**7E-04**	NA	**3E-04**	NA	**4E-04**	NA
Cumulative Media ILCR/HI from Metals and Radionuclides[e,f]:					**1E-03**	**44**	**1E-03**	**139**	**6E-04**	**26**
IDEQ Point of Departure:					10^{-5}	1				
USEPA Risk Range:					10^{-6} - 10^{-4}	1				

Notes:

[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented if the COPC is a Site-related risk driver. Risk estimates for all COPCs are presented in Attachments D and E.

[b] The EPC is based on either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit (UCL) or the maximum detected concentration measured in various media collected from Henry Site sampling locations.

[c] Hazard estimates for antimony and thallium in culturally significant plants harvested from upland soil at the Henry Site are based on the maximum detection limit for these analytes, as they were not detected in Site culturally significant plant tissue. The hazard estimate for antimony in culturally significant plants harvested from upland soil at background locations is based on the maximum detection limit, as antimony was not detected in background culturally significant plant tissue.

[d] The surface water and sediment EPCs for the fish consumption pathway is based on data from sample locations where fish are present or likely to be present.

[e] Cumulative media ILCR/HI for metals includes the higher of the ILCR/HI for culturally significant plants harvested from upland soil, riparian soil, or aquatic environments, and the higher of the ILCR/HI for upland soil or riparian soil direct contact.

[f] Cumulative media ILCR for radium-226 includes the higher of the ILCR for culturally significant plants harvested from upland soil or aquatic environments.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/kg - milligram per kilogram
mg/L - milligram per liter
NA - Not applicable
RME - reasonable maximum exposure
pCi/g - picoCuries per gram
pCi/L - picoCuries per liter
UCL - upper confidence limit
USEPA - U. S. Environmental Protection Agency

Table A3-37
Summary of Tier II RME Henry Site Cumulative Incremental Risk Estimates for Hypothetical Future Residents

Medium/Risk Driver[a]	EPC[b]					Hypothetical Future Resident					
						Site-Related		Background		Incremental	
						ILCR	HI	ILCR	HI	ILCR	HI
Metals	**Upland Soil (mg/kg)**	**Riparian Soil (mg/kg)**	**Surface Water (mg/L)**	**Sediment (mg/kg)**	**Groundwater (mg/L)**						
Fruits and Vegetables - Upland Soil and Groundwater						**2E-03**	**78**	**7E-04**	**42**	**1E-03**	**64**
Antimony	4.81	NA	NA	NA	NA	NA	**2.3**	NA	**24**	NA	0
Arsenic	24.9	NA	NA	NA	0.00227	**2.0E-03**	**10**	**6.6E-04**	**3.4**	**1.3E-03**	**6.7**
Cadmium	32.5	NA	NA	NA	NA	NA	**2.8**	NA	0.73	NA	**2.1**
Cobalt	7.74	NA	NA	NA	0.0100	NA	**1.5**	NA	**2.6**	NA	0
Molybdenum	NA	NA	NA	NA	0.0373	NA	**7.6**	NA	**1.1**	NA	**6.5**
Selenium	46.4	NA	NA	NA	0.0479	NA	**6.2**	NA	0.33	NA	**5.9**
Thallium	1.31	NA	NA	NA	0.000505	NA	**45**	NA	**2.5**	NA	**43**
Uranium	40.5	NA	NA	NA	NA	NA	**1.3**	NA	0.96	NA	0.32
Upland Soil						**5E-05**	**2**	**2E-05**	0.6	**3E-05**	1
Arsenic	24.9	NA	NA	NA	NA	**4.7E-05**	0.24	**1.5E-05**	0.080	**3.1E-05**	0.16
Riparian Soil						NA	NA	NA	NA	NA	NA
Fish - Surface Water and Sediment [c]						**3E-05**	**12**	**3E-05**	**83**	6E-07	0.003
Antimony	NA	NA	ND	4.70	NA	NA	**6.0**	NA	**6.4**	NA	0
Arsenic	NA	NA	0.000750	1.99	NA	**2.8E-05**	0.14	**2.7E-05**	0.14	5.6E-07	0.0029
Thallium	NA	NA	ND	0.122	NA	NA	**6.2**	NA	**76**	NA	0
Surface Water						NA	NA	NA	NA	NA	NA
Groundwater						**6E-05**	**4**	**2E-05**	1	**4E-05**	**3**
Arsenic	NA	NA	NA	NA	0.00227	**6.0E-05**	0.31	**1.9E-05**	0.10	**4.1E-05**	0.21
Cobalt	NA	NA	NA	NA	0.0100	NA	**1.4**	NA	0.060	NA	**1.3**
Thallium	NA	NA	NA	NA	0.000505	NA	**2.1**	NA	0.83	NA	**1.3**
Radionuclides - Radium-226	**Upland Soil (pCi/g)**	**Riparian Soil (pCi/g)**	**Surface Water (pCi/L)**	**Sediment (pCi/g)**	**Groundwater (pCi/L)**						
Fruits and Vegetables - Upland Soil	12.6	NA	NA	NA	NA	**5.1E-04**	NA	**1.9E-04**	NA	**3.1E-04**	NA
Upland Soil	12.6	NA	NA	NA	NA	**2.0E-04**	NA	**7.7E-05**	NA	**1.2E-04**	NA
Fish - Surface Water	NA	NA	0.578	NA	NA	NA	NA	NA	NA	NA	NA
Radionuclides - Radom-222 [d]	**Indoor Air (pCi/m^3)**										
Indoor Air	8,084					**3.3E-02**	NA	**1.6E-02**	NA	**1.8E-02**	NA

Table A3-37
Summary of Tier II RME Henry Site Cumulative Incremental Risk Estimates for Hypothetical Future Residents

Medium/Risk Driver[a]	EPC[b]	Hypothetical Future Resident					
		Site-Related		Background		Incremental	
		ILCR	HI	ILCR	HI	ILCR	HI
	Cumulative Media ILCR/HI from Metals[e]:	**2E-03**	**97**	**7E-04**	**126**	**1E-03**	**69**
	Cumulative Media ILCR from Radionuclides:	**3E-02**	NA	**2E-02**	NA	**2E-02**	NA
	Cumulative Media ILCR/HI from Metals and Radionuclides[e]:	**4E-02**	**97**	**2E-02**	**126**	**2E-02**	**69**
	IDEQ Point of Departure:	10^{-5}	1				
	USEPA Risk Range:	10^{-6} - 10^{-4}	1				

Notes:

[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented if the COPC is a Site-related risk driver. Risk estimates for all COPCs are presented in Attachments D and E.
[b] The EPC is based on either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit (UCL) or the maximum detected concentration measured in various media collected from Henry Site sampling locations.
[c] The surface water and sediment EPCs for the fish consumption pathway is based on data from sample locations where fish are present or likely to be present.
[d] The radon-222 concentration in indoor air was calculated from radon flux measurements made in background upland soil, and is in units of picoCuries per cubic meter (pCi/m^3).
[e] Cumulative media ILCR/HI for metals includes the higher of the ILCR/HI for upland soil or riparian soil direct contact.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/kg - milligram per kilogram
mg/L - milligram per liter
NA - not applicable
RME - reasonable maximum exposure
pCi/g - picoCuries per gram
pCi/L - picoCuries per liter
pCi/m^3 - picoCuries per cubic meter
UCL - upper confidence limit
USEPA - U. S. Environmental Protection Agency

Table A3-38
Summary of Tier II RME Henry Site Cumulative Incremental Risk Estimates for Current / Future Seasonal Ranchers

Medium/Risk Driver[a]	EPC[b]			Current/Future Seasonal Rancher					
				Henry Site		Background		Incremental	
				ILCR	HI	ILCR	HI	ILCR	HI
Metals	**Upland Soil (mg/kg)**	**Surface Water (mg/L)**	**Groundwater (mg/L)**						
Cattle - Upland Soil and Surface Water				**5E-05**	**6**	**2E-05**	**3**	**3E-05**	**3**
Arsenic	24.9	0.00928	NA	**5.0E-05**	0.33	**1.6E-05**	0.10	**3.5E-05**	0.22
Thallium	1.31	0.0000813	NA	NA	**5.0**	NA	**2.1**	NA	**2.9**
Cattle - Upland Soil and Groundwater				**5E-05**	**7**	**2E-05**	**3**	**3E-05**	**4**
Arsenic	24.9	NA	0.00227	**4.8E-05**	0.31	**1.6E-05**	0.10	**3.2E-05**	0.21
Thallium	1.31	NA	0.000505	NA	**5.6**	NA	**2.2**	NA	**3.4**
Upland Soil				**8E-06**	0.4	**3E-06**	0.1	**5E-06**	0.2
Arsenic	24.9	NA	NA	**8.0E-06**	0.052	**2.6E-06**	0.017	**5.3E-06**	0.035
Groundwater				**1E-05**	0.05	**4E-06**	0.01	**8E-06**	0.04
Arsenic	NA	NA	0.00227	**1.1E-05**	0.0034	**3.5E-06**	0.0011	**7.5E-06**	0.0024
Radionuclides - Radium-226	**Upland Soil (pCi/g)**	**Surface Water (pCi/L)**	**Groundwater (pCi/L)**						
Cattle - Upland Soil	12.6	NA	NA	**2.0E-05**	NA	**7.6E-06**	NA	**1.2E-05**	NA
Upland Soil	12.6	NA	NA	**4.2E-04**	NA	**1.6E-04**	NA	**2.6E-04**	NA
Cumulative Media ILCR/HI from Metals[d]:				**7E-05**	**7**	**2E-05**	**3**	**5E-05**	**4**
Cumulative Media ILCR from Radionuclides[d]:				**4E-04**	NA	**2E-04**	NA	**3E-04**	NA
Cumulative Media ILCR/HI from Metals and Radionuclies[d]:				**5E-04**	**7**	**2E-04**	**3**	**3E-04**	**4**
IDEQ Point of Departure: **USEPA Risk Range:**				10^{-5} 10^{-6} - 10^{-4}	1 1				

Notes:

[a] Summary of risk estimates for constituents of potencial concern (COPCs) are presented if the COPC is a Henry Site risk driver. Risk estimates for all COPCs are presented in Attachments D and E.

[b] The EPC is based on the lower of the ProUCL recommended 95%, 97.5% or 99% upper confidence limit (UCL) or the maximum detected concentration measured in various media collected from Henry Site sampling locations.

[c] Cumulative media ILCR/HI for metals includes the higher of the ILCR/HI for consumption of cattle that have ingested surface water or groundwater. Surface water and ground water ingestion by cattle were not evaluated for radium-226 because uranium, and therefore radium-226, was not identified as a chemical of potential concern for these media.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/kg - milligram per kilogram
mg/L - milligram per liter
NA - Not applicable
pCi/g - picoCuries per gram
pCi/L - picoCuries per liter
RME - reasonable maximum exposure
UCL - upper confidence limit
USEPA - U. S. Environmental Protection Agency

Table A3-39
Summary of Tier II RME Henry Site Cumulative Incremental Risk Estimates for Current / Future Recreational Hunters

Medium/Risk Driver[a]	EPC[b]		Current/Future Recreational Hunter					
			Henry Site		Background		Incremental	
			ILCR	HI	ILCR	HI	ILCR	HI
Metals	**Upland Soil (mg/kg)**	**Surface Water (mg/L)**						
Elk - Upland Soil and Surface Water			NA	NA	NA	NA	NA	NA
Upland Soil			8E-07	0.04	3E-07	0.01	5E-07	0.02
Radionuclides - Radium-226	**Upland Soil (pCi/g)**	**Surface Water (pCi/L)**						
Elk - Upland Soil	12.6	NA	NA	NA	NA	NA	NA	NA
Upland Soil	12.6	NA	**9.7E-05**	NA	**3.7E-05**	NA	**6.0E-05**	NA
Cumulative Media ILCR/HI for Metals:			8E-07	0.04	3E-07	0.01	5E-07	0.02
Cumulative Media ILCR for Radionuclides:			**1E-04**	NA	**4E-05**	NA	**6E-05**	NA
Cumulative Media ILCR/HI from Metals and Radionuclides:			**1E-04**	0.04	**4E-05**	0.01	**6E-05**	0.02
IDEQ Point of Departure:			10^{-5}	1				
USEPA Risk Range:			10^{-6} - 10^{-4}	1				

Notes:

[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented if the COPC is a Henry Site risk driver. Risk estimates for all COPCs are presented in Appendix A.

[b] The EPC is based on either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit (UCL) or the maximum detected concentration measured in various media collected from Henry Site sampling locations.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/kg - milligram per kilogram
mg/L - milligram per liter
NA - Not applicable
RME - reasonable maximum exposure
UCL - upper confidence limit
USEPA - U. S. Environmental Protection Agency

Table A3-40
Summary of Tier II RME Henry Site Cumulative Incremental Risk Estimates for Current / Future Recreational Camper / Hikers

Medium/Risk Driver[a]	EPC[b]	Current/Future Recreational Camper/Hiker					
		Henry Site		Background		Incremental	
		ILCR	HI	ILCR	HI	ILCR	HI
Metals	**Upland Soil (mg/kg)**						
Upland Soil		1E-06	0.04	4E-07	0.01	8E-07	0.03
Radionuclides - Radium-226	**Upland Soil (pCi/g)**						
Upland Soil	12.6	**6.0E-05**	NA	**2.3E-05**	NA	**3.7E-05**	NA
Cumulative Media ILCR/HI from Metals:		1E-06	0.04	4E-07	0.01	8E-07	0.03
Cumulative Media ILCR from Radionuclides:		**6E-05**	NA	**2E-05**	NA	**4E-05**	NA
Cumulative Media ILCR/HI from Metals and Radionuclides:		**6E-05**	0.04	**2E-05**	0.01	**4E-05**	0.03
IDEQ Point of Departure:		10^{-5}	1	10^{-5}	1	10^{-5}	1
USEPA Risk Range:		10^{-6} - 10^{-4}	1	10^{-6} - 10^{-4}	1	10^{-6} - 10^{-4}	1

Notes:

[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented if the COPC is a Henry Site risk driver. Risk estimates for all COPCs are presented in Attachments D and E.

[b] The EPC is based on either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit (UCL) or the maximum detected concentration measured in various media collected from Henry Site sampling locations.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
mg/kg - milligram per kilogram
RME - reasonable maximum exposure
pCi/g - picoCuries per gram
UCL - upper confidence limit
USEPA - U. S. Environmental Protection Agency

Table A3-41
Summary of Tier II RME Henry Site Cumulative Incremental Risk Estimates for Current / Future Recreational Fishers

Medium/Risk Driver[a]	EPC[b]			Current/Future Recreational Fisher					
				Site-Related		Background		Incremental	
				ILCR	HI	ILCR	HI	ILCR	HI
Metals	**Riparian Soil (mg/kg)**	**Surface Water (mg/L)**	**Sediment (mg/kg)**						
Riparian Soil				NA	NA	NA	NA	NA	NA
Fish - Surface Water and Sediment [c]				**3E-05**	**12**	**3E-05**	**83**	6E-07	0.003
Antimony	NA	ND	4.70	NA	**6.0**	NA	**6.4**	NA	0
Arsenic	NA	0.000750	1.99	**2.8E-05**	0.14	**2.7E-05**	0.14	5.6E-07	0.0029
Thallium	NA	ND	0.122	NA	**6.2**	NA	**76**	NA	0
Surface Water				NA	NA	NA	NA	NA	NA
Cumulative Media ILCR/HI from Metals[d]:				**3E-05**	**12**	**3E-05**	**83**	6E-07	0.003
IDEQ Point of Departure:				10^{-5}	1				
USEPA Risk Range:				10^{-6} - 10^{-4}	1				

Notes:

[a] Summary of risk estimates for constituents of potential concern (COPCs) are presented if the COPC is a Site-related risk driver. Risk estimates for all COPCs are presented in Attachments D and E.

[b] The EPC is based on either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit (UCL) or the maximum detected concentration measured in various media collected from Henry Site sampling locations.

[c] The surface water and sediment EPCs for the fish consumption pathway is based on data from sample locations where fish are present or likely to be present.

[d] Cumulative Media ILCR is calculated based on exposure to metals only, as risks associated with exposure to radium-226 was de minimus in the Tier II risk assessment and therefore not carried in to the Tier II risk assessment.

Bold indicates exceedance of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

EPC - Exposure Point Concentration
HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk

mg/kg - milligram per kilogram
mg/L - milligram per liter
NA - Not applicable
RME - reasonable maximum exposure

pCi/g - picoCuries per gram
pCi/L - picoCuries per liter
UCL - upper confidence limit
USEPA - U. S. Environmental Protection Agency

TABLES

SECTION 4

Table A4-1
Selection of Constituents of Potential Ecological Concern in Upland Soil
Henry Site

Analyte	Maximum Detected Concentration (mg/kg)	Eco-SSL [a] (mg/kg) Plants	Eco-SSL [a] (mg/kg) Soil Invertebrates	Eco-SSL [a] (mg/kg) Avian	Eco-SSL [a] (mg/kg) Mammalian	ORNL Ecological Benchmark [b] (mg/kg) Plants	ORNL Ecological Benchmark [b] (mg/kg) Soil Microbes	ORNL Ecological Benchmark [b] (mg/kg) Soil Invertebrates	Avian and Mammal Soil Screening Level (mg/kg)	Lowest Soil Screening Level (mg/kg)	Avian and Mammal [c] COPEC (Yes/No)	Preliminary [d] COPEC (Yes/No)
Antimony	9.15	- -	78	- -	0.27	5	- -	- -	0.27	0.27	**Yes**	**Yes**
Arsenic	45.5	18	- -	43	46	10	100	60	43	10	**Yes**	**Yes**
Boron	39.0	- -	- -	- -	- -	0.5	20	- -	- -	0.50	**Yes**	**Yes**
Cadmium	59.5	32	140	0.77	0.36	4	20	20	0.36	0.36	**Yes**	**Yes**
Chromium [e]	519	- -	- -	26	34	1	10	0.4	26	0.40	**Yes**	**Yes**
Cobalt	11.9	13	- -	120	230	20	1,000	- -	120	13	No	No
Copper	172	70	80	28	49	100	100	50	28	28	**Yes**	**Yes**
Manganese	2,040	220	450	4,300	4,000	500	100	- -	4,000	100	No	**Yes**
Mercury	0.503	- -	- -	- -	- -	0.3	30	0.1 [f]	- -	0.10	**Yes**	**Yes**
Molybdenum	35.7	- -	- -	- -	- -	2	200	- -	- -	2.0	**Yes**	**Yes**
Nickel	425	38	280	210	130	30	90	200	130	30	**Yes**	**Yes**
Selenium	318	0.52	4.1	1.2	0.63	1.00	100	70	0.63	0.52	**Yes**	**Yes**
Silver	7.30	560	- -	4.2	14	2	50	- -	4.2	2.0	**Yes**	**Yes**
Thallium	2.31	- -	- -	- -	- -	1	- -	- -	- -	1.0	**Yes**	**Yes**
Uranium	74.4	- -	- -	- -	- -	5	- -	- -	- -	5.0	**Yes**	**Yes**
Vanadium	584	- -	- -	7.8	280	2	20	- -	7.8	2.0	**Yes**	**Yes**
Zinc	1,610	160	120	46	79	50	100	200	46	46	**Yes**	**Yes**

Notes:

[a] USEPA Ecological Soil Screening Levels (USEPA, various).

[b] Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants (ORNL, 1997a), soil invertebrates and microbes (ORNL, 1997b).

[c] Maximum detected concentration exceeds the lower of avian and mammalian Eco-SSLs, or no avian or mammalian Eco-SSLs are available.

[d] Maximum detected concentration exceeds the respective lowest soil screening level.

[e] Measured as total chromium; however, because chromium VI was not detected in soil samples, total chromium is assumed to be represented by chromium III.

[f] Based on a lowest observed effects concentration (LOEC) of 0.5 mg/kg for reduction in soil invertebrate survival cocoon production with an applied safety factor of 5.

"- -" - not available
COPEC - constituent of potential ecological concern
Eco-SSL - ecological soil screening level
mg/kg - milligrams per kilogram
ORNL - Oak Ridge National Laboratory
USEPA - United States Environmental Protection Agency

Table A4-2
Selection of Constituents of Potential Ecological Concern in Riparian Soil
Henry Site

Analyte	Maximum Detected Concentration (mg/kg)	Eco-SSL [a] (mg/kg) Plants	Eco-SSL Soil Invertebrates	Eco-SSL Avian	Eco-SSL Mammalian	ORNL Ecological Benchmark [b] (mg/kg) Plants	ORNL Soil Microbes	ORNL Soil Invertebrates	Avian and Mammal Soil Screening Level (mg/kg)	Lowest Soil Screening Level (mg/kg)	Avian and Mammal [c] COPEC (Yes/No)	Preliminary [d] COPEC (Yes/No)
Antimony	7.00	- -	78	- -	0.27	5	- -	- -	0.27	0.27	**Yes**	**Yes**
Arsenic	4.99	18	- -	43	46	10	100	60	43	10	No	No
Boron	5.90	- -	- -	- -	- -	0.5	20	- -	- -	0.50	**Yes**	**Yes**
Cadmium	67.3	32	140	0.77	0.36	4	20	20	0.36	0.36	**Yes**	**Yes**
Chromium [e]	467	- -	- -	26	34	1	10	0.4	26	0.40	**Yes**	**Yes**
Cobalt	8.73	13	- -	120	230	20	1,000	- -	120	13	No	No
Copper	56.0	70	80	28	49	100	100	50	28	28	**Yes**	**Yes**
Manganese	1,080	220	450	4,300	4,000	500	100	- -	4,000	100	No	**Yes**
Mercury	0.024	- -	- -	- -	- -	0.3	30	0.1 [f]	- -	0.10	**Yes**	**Yes**
Molybdenum	14.8	- -	- -	- -	- -	2	200	- -	- -	2.0	**Yes**	**Yes**
Nickel	251	38	280	210	130	30	90	200	130	30	**Yes**	**Yes**
Selenium	45.0	0.52	4.1	1.2	0.63	1.00	100	70	0.63	0.52	**Yes**	**Yes**
Silver	0.125	560	- -	4.2	14	2	50	- -	4.2	2.0	No	No
Thallium	0.223	- -	- -	- -	- -	1	- -	- -	- -	1.0	**Yes**	**Yes**
Uranium	1.66	- -	- -	- -	- -	5	- -	- -	- -	5.0	**Yes**	**Yes**
Vanadium	773	- -	- -	7.8	280	2	20	- -	7.8	2.0	**Yes**	**Yes**
Zinc	1,600	160	120	46	79	50	100	200	46	46	**Yes**	**Yes**

Notes:

[a] USEPA Ecological Soil Screening Levels (USEPA, various).

[b] Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants (ORNL, 1997a), soil invertebrates and microbes (ORNL, 1997b).

[c] Maximum detected concentration exceeds the lower of avian and mammalian Eco-SSLs, or no avian or mammalian Eco-SSLs are available.

[d] Maximum detected concentration exceeds the respective lowest soil screening level.

[e] Measured as total chromium; however, because chromium VI was not detected in soil samples, total chromium is assumed to be represented by chromium III.

[f] Based on a lowest observed effects concentation (LOEC) of 0.5 mg/kg for reduction in soil invertebrate survival cocoon production with an applied safety factor of 5.

"- -" - not available
COPEC - constituent of potential ecological concern
Eco-SSL - ecological soil screening level
mg/kg - milligrams per kilogram
ORNL - Oak Ridge National Laboratory
USEPA - United States Environmental Protection Agency

Table A4-3
Selection of Constituents of Potential Ecological Concern in Upstream Surface Water
Henry Site

Analyte	Maximum Detected Concentration (mg/L)	State of Idaho Standards [1] Aquatic Life (mg/L)	National Standards Aquatic Life [2] (mg/L)	ORNL Toxicological Benchmarks: Lowest Chronic Value [3] (mg/L)	ORNL Toxicological Benchmarks: Tier II SCV [4] (mg/L)	ORNL Toxicological Benchmarks: Lowest Population EC20 [5] (mg/L)	Proposed COPEC Screening Criteria (mg/L)	Preliminary COPEC (Yes/No)
Aluminum, dissolved	0.0300	--	0.087	0.46	--	--	0.087	No
Antimony, dissolved	0.00230	--	--	5.4	0.030	0.079	0.030	No
Arsenic, dissolved	0.00790	0.15	0.15	0.914	--	2.0	0.15	No
Barium, dissolved	0.0710	--	--	--	0.0040	--	0.0040	**Yes**
Boron, dissolved	0.0200	--	--	8.83	0.0016	--	0.0016	**Yes**
Cadmium, dissolved	0.00780	0.0013 [a]	0.00064 [b]	0.00015	--	0.0043	0.0013	**Yes**
Calcium, dissolved	281	--	--	116	--	--	116	No [e]
Chromium, dissolved	0.00260	0.23/0.011 [a,c]	0.23/0.011 [b,c]	<0.044	--	0.13	0.011	No
Iron, dissolved	0.160	--	1.0	0.158	--	--	1.0	No
Lead, dissolved	0.000430	0.011 [a]	0.011 [b]	0.0123	--	0.071	0.011	No
Magnesium, dissolved	58.2	--	--	82	--	--	82	No [e]
Manganese, dissolved	0.538	--	--	<1.1	0.12	0.112	0.112	**Yes**
Molybdenum, dissolved	0.0300	--	--	0.88	0.37	--	0.37	No
Nickel, dissolved	0.0646	0.17 [a]	0.17 [b]	<0.005	--	0.215	0.17	No
Potassium, dissolved	5.10	--	--	53	--	--	53	No
Selenium, total	0.290	0.005	0.0031 [d]	0.088	--	--	0.0050	**Yes**
Sodium, dissolved	19.0	--	--	680	--	--	680	No [e]
Uranium, dissolved	0.0134	--	--	0.142	0.0026	0.027	0.0026	**Yes**
Vanadium, dissolved	0.0402	--	--	0.08	0.02	0.32	0.020	**Yes**
Zinc, dissolved	0.142	0.38 [a]	0.38 [b]	0.03	--	0.08	0.38	No

Notes:

[1] State of Idaho Surface Water Quality for Aquatic Life (IDAPA 58.01.02)(IAC, 2009a); CCC listed for all analytes except for silver. Only a CMC is available for silver.
[2] National Recommended Water Quality Criteria (USEPA, 2015b); Freshwater CCC listed for all analytes except for silver. Only a CMC is available for silver.
[3] Lowest Chronic Value observed in freshwater daphnids. Source: ORNL, 1996a.
[4] Tier II Secondary Chronic Value. Source: ORNL, 1996a.
[5] Lowest Population EC_{20}. Source: ORNL, 1996a.

[a] Aquatic life criteria for these metals are expressed as a function of total hardness (mg/L as calcium carbonate), the pollutant's water effect ratio as defined in Subsection 210.03.c.iii of IDAPA 58.01.02 (IAC, 2009a) and multiplied by an appropriate dissolved conversion factor as defined in Subsection 210.02, as applicable. The values displayed in this table are shown as dissolved metal and correspond to a total hardness of 400 mg/L and a water effect ratio of 1.0.
[b] The freshwater criterion for this metal is expressed as a function of hardness in the water column. The value given here corresponds to a hardness of 400 mg/L. Criteria values for other hardness may be calculated from the following: CMC (dissolved) = exp {mA[ln(hardness)]+bA} (CF), or CCC (dissolved) = exp {mC[ln(hardness)]+bC} (CF) and the parameters specified in Appendix B of National Recommended Water Quality Criteria (USEPA, 2015b).
[c] Values specified are listed as chromium III/chromium VI. Consistent with the Agencies and Tribes-approved Remedial Investigation and Feasibility Study Work Plan for the P4 Sites (MWH, 2011), the total chromium results are compared to the hexavalent chromium standard.
[d] The 2016 United States Environmental Protection Agency (USEPA) selenium criterion for lotic systems is applicable to upstream surface water locations.
[e] This analyte is excluded as a COPEC based on essential nutrient status.

"- -" - not available
CCC - Criterion Continuous Concentration
CMC - Criteria Maximum Concentration
COPEC - constituent of potential ecological concern
EC20 - 20 percent effects concentration
IDAPA Idaho Administrative Procedures Act
mg/L - milligrams per liter
ORNL - Oak Ridge National Laboratory
RL - reporting limit
RMP - Resource Management Plan
SCV - secondary chronic values

Table A4-4
Selection of Constituents of Potential Ecological Concern in Downstream Surface Water
Henry Site

Analyte	Maximum Detected Concentration (mg/L)	State of Idaho Standards [1] Aquatic Life (mg/L)	National Standards Aquatic Life [2] (mg/L)	ORNL Toxicological Benchmarks			Proposed COPEC Screening Criteria (mg/L)	Preliminary COPEC (Yes/No)
				Lowest Chronic Value [3] (mg/L)	Tier II SCV [4] (mg/L)	Lowest Population EC20 [5] (mg/L)		
Aluminum, dissolved	0.844	--	0.087	0.46	--	--	0.087	**Yes**
Arsenic, dissolved	0.0224	0.15	0.15	0.914	--	2.0	0.15	No
Barium, dissolved	0.0810	--	--	--	0.0040	--	0.0040	**Yes**
Boron, dissolved	0.121	--	--	8.83	0.0016	--	0.0016	**Yes**
Cadmium, dissolved	0.000166	0.00098 [a]	0.00047 [b]	0.00015	--	0.0043	0.00098	No
Calcium, dissolved	142	--	--	116	--	--	116	No [e]
Chromium, dissolved	0.00343	0.16/0.011 [a,c]	0.16/0.011 [b,c]	<0.044	--	0.13	0.011	No
Cobalt, dissolved	0.0141	--	--	0.0051	0.023	0.0040	0.0040	**Yes**
Copper, dissolved	0.00379	0.025 [a]	BLM [d]	0.00023	--	0.00021	0.025	No
Iron, dissolved	0.827	--	1.0	0.158	--	--	1.0	No
Lead, dissolved	0.000400	0.0069 [a]	0.0069 [b]	0.0123	--	0.071	0.0069	No
Magnesium, dissolved	49.2	--	--	82	--	--	82	No
Manganese, dissolved	2.33	--	--	<1.1	0.12	0.112	0.112	**Yes**
Molybdenum, dissolved	0.0192	--	--	0.88	0.37	--	0.37	No
Nickel, dissolved	0.0265	0.12 [a]	0.12 [b]	<0.005	--	0.215	0.12	No
Potassium, dissolved	102	--	--	53	--	--	53	No [e]
Selenium, total	0.0460	0.005	0.0031 [f]	0.088	--	--	0.0050	**Yes**
Sodium, dissolved	68.6	--	--	680	--	--	680	No
Thallium, dissolved	0.000348	--	--	0.13	0.012	0.067	0.012	No
Uranium, dissolved	0.0206	--	--	0.142	0.0026	0.027	0.0026	**Yes**
Vanadium, dissolved	0.0885	--	--	0.08	0.02	0.32	0.020	**Yes**
Zinc, dissolved	0.110	0.26 [a]	0.26 [b]	0.03	--	0.08	0.26	No

Notes:

[1] State of Idaho Surface Water Quality for Aquatic Life (IDAPA 58.01.02) (IAC, 2009a); CCC listed for all analytes except for silver. Only a CMC is available for silver.

[2] National Recommended Water Quality Criteria (USEPA, 2015b); Freshwater CCC listed for all analytes except for silver. Only a CMC is available for silver.

[3] Lowest Chronic Value observed in freshwater daphnids. Source: ORNL, 1996a.

[4] Tier II Secondary Chronic Value. Source: ORNL, 1996a.

[5] Lowest Population EC_{20}. Source: ORNL, 1996a.

[a] Aquatic life criteria for these metals are expressed as a function of total hardness (mg/L as calcium carbonate), the pollutant's water effect ratio as defined in Subsection 210.03.c.iii of IDAPA 58.01.02 (IAC, 2009a) and multiplied by an appropriate dissolved conversion factor as defined in Subsection 210.02, as applicable. The values displayed in this table are shown as dissolved metal and correspond to a total hardness of 256 mg/L and a water effect ratio of 1.0.

[b] The freshwater criterion for this metal is expressed as a function of hardness in the water column. The value given here corresponds to a hardness of 256 mg/L. Criteria values for other hardness may be calculated from the following: CMC (dissolved) = exp {mA[ln(hardness)]+bA} (CF), or CCC (dissolved) = exp {mC[ln(hardness)]+bC} (CF) and the parameters specified in Appendix B of National Recommended Water Quality Criteria (USEPA, 2015b).

[c] Values specified are for chromium III/VI. Consistent with the Agencies and Tribes-approved Remedial Investigation and Feasibility Study Work Plan for the P4 Sites (MWH, 2011), the total chromium results are compared to the hexavalent chromium standard.

[d] Freshwater criteria calculated using the BLM - See Document (http://www.epa.gov/wqc/aquatic-life-criteria-copper)

[e] This analyte is excluded as a COPEC based on essential nutrient status.

[f] The 2016 United States Environmental Protection Agency (USEPA) selenium criterion for lotic systems is applicable to downstream surface water locations.

"- -" - not available	COPEC - constituent of potential ecological concern	ORNL - Oak Ridge National Laboratory
BLM - biotic ligand model	EC20 - 20 percent effects concentration	RL - reporting limit
CCC - Criterion Continuous Concentration	IDAPA Idaho Administrative Procedures Act	RMP - Resource Management Plan
CMC - Criteria Maximum Concentration	mg/L - milligrams per liter	SCV - secondary chronic values

Table A4-5
Selection of Constituents of Potential Ecological Concern in Pond Surface Water
Henry Site

Analyte	Maximum Detected Concentration (mg/L)	State of Idaho Standards [1] Aquatic Life (mg/L)	National Standards Aquatic Life [2] (mg/L)	ORNL Toxicological Benchmarks			Proposed COPEC Screening Criteria (mg/L)	Preliminary COPEC (Yes/No)
				Lowest Chronic Value [3] (mg/L)	Tier II SCV [4] (mg/L)	Lowest Population EC20 [5] (mg/L)		
Aluminum, dissolved	0.905	--	0.087	0.46	--	--	0.087	**Yes**
Antimony, dissolved	0.000800	--	--	5.4	0.030	0.079	0.030	No
Arsenic, dissolved	0.0129	0.15	0.15	0.914	--	2.0	0.15	No
Barium, dissolved	0.0380	--	--	--	0.0040	--	0.0040	**Yes**
Boron, dissolved	0.0402	--	--	8.83	0.0016	--	0.0016	**Yes**
Cadmium, dissolved	0.0352	0.0013 [a]	0.00064 [b]	0.00015	--	0.0043	0.0013	**Yes**
Calcium, dissolved	232	--	--	116	--	--	116	No [f]
Chromium, dissolved	0.00760	0.23/0.011 [a,c]	0.23/0.011 [b,c]	<0.044	--	0.13	0.011	No
Cobalt, dissolved	0.00303	--	--	0.0051	0.023	0.0040	0.0040	No
Copper, dissolved	0.00177	0.037 [a]	BLM [d]	0.00023	--	0.00021	0.037	No
Iron, dissolved	0.877	--	1.0	0.158	--	--	1.0	No
Magnesium, dissolved	62.6	--	--	82	--	--	82	No
Manganese, dissolved	2.4	--	--	<1.1	0.12	0.112	0.112	**Yes**
Molybdenum, dissolved	0.0400	--	--	0.88	0.37	--	0.37	No
Nickel, dissolved	1.26	0.17 [a]	0.17 [b]	<0.005	--	0.215	0.17	**Yes**
Potassium, dissolved	9.30	--	--	53	--	--	53	No
Selenium, total	0.970	0.005	0.0015 [e]	0.088	--	--	0.0050	**Yes**
Sodium, dissolved	10.5	--	--	680	--	--	680	No
Thallium, dissolved	0.000200	--	--	0.13	0.012	0.067	0.012	No
Uranium, dissolved	0.00493	--	--	0.142	0.0026	0.027	0.0026	**Yes**
Vanadium, dissolved	0.0689	--	--	0.08	0.02	0.32	0.020	**Yes**
Zinc, dissolved	4.73	0.38 [a]	0.38 [b]	0.03	--	0.08	0.38	**Yes**

Notes:

[1] State of Idaho Surface Water Quality for Aquatic Life (IDAPA 58.01.02); CCC listed for all analytes except for silver. Only a CMC is available for silver.

[2] National Recommended Water Quality Criteria (USEPA, 2015b); Freshwater CCC listed for all analytes except for silver. Only a CMC is available for silver.

[3] Lowest Chronic Value observed in freshwater daphnids. Source: ORNL, 1996a.

[4] Tier II Secondary Chronic Value. Source: ORNL, 1996a.

[5] Lowest Population EC_{20}. Source: ORNL, 1996a.

[a] Aquatic life criteria for these metals are expressed as a function of total hardness (mg/L as calcium carbonate), the pollutant's water effect ratio as defined in Subsection 210.03.c.iii of IDAPA 58.01.02 (IAC, 2009a) and multiplied by an appropriate dissolved conversion factor as defined in Subsection 210.02, as applicable. The values displayed in this table are shown as dissolved metal and correspond to a total hardness of 400 mg/L and a water effect ratio of 1.0.

[b] The freshwater criterion for this metal is expressed as a function of hardness in the water column. The value given here corresponds to a hardness of 400 mg/L. Criteria values for other hardness may be calculated from the following: CMC (dissolved) = exp {mA[ln(hardness)]+bA} (CF), or CCC (dissolved) = exp {mC[ln(hardness)]+bC} (CF) and the parameters specified in Appendix B of National Recommended Water Quality Criteria (USEPA, 2015b).

[c] Values specified are for chromium III/VI. Consistent with the Agencies and Tribes-approved Remedial Investigation and Feasibility Study Work Plan for the P4 Sites (MWH, 2011), the total chromium results are compared to the hexavalent chromium standard.

[d] Freshwater criteria calculated using the BLM - See Document (http://www.epa.gov/wqc/aquatic-life-criteria-copper)

[e] The 2016 United States Environmental Protection Agency (USEPA) selenium criterion for lentic systems is applicable to pond surface water locations.

[f] This analyte is excluded as a COPEC based on essential nutrient status.

"- -" - not available
BLM - biotic ligand model
CCC - Criterion Continuous Concentration
CMC - Criteria Maximum Concentration
COPEC - constituent of potential ecological concern
EC20 - 20 percent effects concentration
IDAPA Idaho Administrative Procedures Act
mg/L - milligrams per liter
ORNL - Oak Ridge National Laboratory
RL - reporting limit
RMP - Resource Management Plan
SCV - secondary chronic values

Table A4-6
Selection of Chemicals of Potential Ecological Concern in Sediment
Henry Site

Analyte	Maximum Detected Concentration (mg/kg)	Sediment Screening Level [a] (mg/kg)	Preliminary Sediment COPEC (Yes/No)
Antimony	8.50	2.0	**Yes**
Arsenic	10.6	9.8	**Yes**
Boron	17.4	- -	**Yes**
Cadmium	104	0.99	**Yes**
Chromium	1,030	43	**Yes**
Cobalt	10.6	50	No
Copper	68.8	32	**Yes**
Manganese	2,580	460	**Yes**
Mercury	0.236	0.18	**Yes**
Molybdenum	10.8	- -	**Yes**
Nickel	1,110	23	**Yes**
Selenium	148	2.0	**Yes**
Silver	2.16	1.0	**Yes**
Thallium	2.17	- -	**Yes**
Uranium	90.0	- -	**Yes**
Vanadium	940	- -	**Yes**
Zinc	7,940	121	**Yes**

Notes:

[a] Sediment screening levels are based on the USEPA Region 3 BTAG freshwater sediment screening benchmarks, unless otherwise noted (USEPA, 2006b).

"- -" - not available
ARCS - assessment and remediation of contaminated sediments
BTAG - Biological Technical Assistance Group
COPEC - chemicals of potential ecological concern
mg/kg - milligrams per kilogram
NOAA - National Oceanic and Atmospheric Administration
SQuiRT table - Screening Quick Reference Tables
TEL - threshold effects level
USEPA - United States Environmental Protection Agency

Table A4-7
Summary of Chemicals of Potential Ecological Concern
Henry Site

Analyte	Upland Soil	Riparian Soil	Surface Water [a]	Sediment
Aluminum			X	
Antimony	X	X		X
Arsenic	X			X
Barium			X	
Beryllium				
Boron	X	X	X	X
Cadmium	X	X	X	X
Calcium				
Chromium	X	X		X
Cobalt			X	
Copper	X	X		X
Iron				
Lead				
Magnesium				
Manganese	X [b]	X [b]	X	X
Mercury	X	X		X
Molybdenum	X	X		X
Nickel	X	X	X	X
Potassium				
Selenium	X	X	X	X
Silver	X			X
Sodium				
Thallium	X	X		X
Uranium	X	X	X	X
Vanadium	X	X	X	X
Zinc	X	X	X	X

Notes:

[a] Dissolved fraction for all analytes except for selenium, which is expressed as total selenium.

[b] Ecological hazard for avian and mammalian receptors was not evaluated for this chemical in soil because this chemical was not identifed as an avian and mammal chemical of potential ecological concern. Avian and mammalian ecological hazards associated with surface water exposures to this chemical were estimated.

X - chemical of potential ecological concern

Table A4-8
Functional Use of P4 Mine Ponds - Henry Site

Pond Name	Pond ID	Tier*
Henry Pond [#1,2]	SP014	1
Smith Pond [#11]	SP015	2
Center Henry Pond [#3]	SP016	1
South Pit Pond [#24]	SP055	3

* As reported in the functional use survey (IDEQ, 2004c)

Table A4-9
Stream Survey RBP Summary Results - Henry Site

Mine	Number of Stations Evaluated (including background)	RBP Score Range	Fish Presence		Percent of Stations with Confirmed or Likely Fish
			Observed	Likely	
Henry	20	7-153	5 (RBP 52-151)	5 (RBP 31-143)	50

Note:

The highest RBP habitat score possible is 200.
RBP - Rapid Bioassessment Protocols

Table A4-10
Area- and Site-Specific Ecological Studies

Matrix Sampled	Year Sampled	Area Sampled	COPCs	Report
Fish	1999, 2000	Area-wide	Selenium, Cadmium	1999-2000 Regional Investigation Data Report for Surface Water, Sediment and Aquatic Biota Sampling Activities, May-June 2000. Appendix C (MW, 2001)
Benthic Invertebrates	1999, 2000	Area-wide	Selenium, Cadmium	1999-2000 Regional Investigation Data Report for Surface Water, Sediment and Aquatic Biota Sampling Activities, May-June 2000. Appendix C (MW, 2001)
Elk	1999, 2000	Area-wide	Selenium, Cadmium	1999 Interim Investigation Data Report, Appendices H, J (MW, 2000)
Bird Eggs	1999, 2000, 2001	Area-wide	Selenium, Cadmium	1999 Interim Investigation Data Report (MW, 2000)
Cutthroat Trout	1999	Area-wide	Selenium	1999 Interim Investigation Data Report (MW, 2000)
2001 Small Mammals	2001	Area-wide	Selenium, Aluminum, Vanadium, Zinc , Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Copper, Lead, Manganese, Mercury, Molybdenum, Nickel, Silver, Thallium, Uranium	Summer 2001 Area-Wide Investigation Data Summary, Appendices B-E (MWH, 2002)
Terrestrial Invertebrates	2001	Area-wide	Selenium, Aluminum, Vanadium, Zinc, Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Copper, Lead, Manganese, , Molybdenum, Nickel, Silver, Thallium, Uranium, Mercury	Summer 2001 Area-Wide Investigation Data Summary, Appendices B-E (MWH, 2002)
Fish	2004	Mine Specific	Selenium, Cadmium, Nickel, Vanadium, Zinc	Phase I Site Investigation Summary Report (MWH, 2007)
Benthic Invertebrates	2004	Mine Specific	Selenium	Phase I Site Investigation Summary Report (MWH, 2007)

Notes:

Alternate bird egg study reference:
Analysis of Selenium Levels in Bird Eggs and Assessment of the Effects of Selenium on Avian Reproduction in Southeast Idaho prepared by J.T. Ratti, A. Rocklage and E.O. Garton, University of Idaho, published in The Journal of Wildlife Management

Alternate cutthroat trout study reference:
Data presented in: Effects of dietary selenium on cutthroat trout (*Oncorhynchus clarki*) growth and reproductive performance. From Ron Hardy, University of Idaho (2005).

Tables A4-11
Regional Fish

Common Name	Species Name	Sampled
Family Catostomidae (Suckers; trophic level 2-3; benthic)		
Longnose Sucker	Catostomus catostomus	√
Mountain Sucker	Catostomus platyrhynchus	√
White Sucker	Catostomus commersoni	√
Family Catostomidae (Sculpins; trophic level 2-3; benthic)		
Bear Lake sculpin	Cottus extensus	√
Family Cyprinidae (Minnows or carps; trophic level 2-3; benthopelagic)		
Leatherside chub	Gila copei	
Utah chub	Gila atraria	√
Common dace	Leuciscus leuciscus	√
Longnose dace	Rhinichthys cataractae	
Speckled dace	Rhinichthys osculus	
Red shiner	Notropis lutrensis	
Redside shiner	Richardsonius balteatus	√
Common carp	Cyprinus carpio	
Family Percidae (Perches; trophic level 3; benthopelagic)		
Yellow perch	Perca flavescens	√
Family Salmonidae (salmon; trophic level 3-4; benthopelagic - pelagic)		
Bear Lake whitefish	Prosopium abyssicola	
Bonneville whitefish	Prosopium spilonotus	
Mountain whitefish	Prosopium williamsoni	√
Bonneville cisco	Prosopium gemmifer	
Brook Trout	Salvelinus fontinalis	√
Brown Trout	Salmo trutta	
Rainbow Trout	Oncorhynchus mykiss	√
Bear Lake cutthroat trout	Oncorhynchus clarki pop 3	
Bonneville cutthroat trout	Oncorhynchus clarki Utah	
Snake River Fine-Spotted Cutthroat	Oncorhynchus clarki ssp2	
Yellowstone cutthroat trout	Oncorhynchus clarki Bouvieri	√

Notes:
Species list source: MW, 1999
Trophic level source: USEPA, 1995
Habitat source: Froese and Pauly, 2010

Tables A4-12
Regional Birds

Common Name	Species Name	Sampled	Trophic Level
Seabirds, Heron-like Birds, and Kingfishers - piscivorous diet			
Family Peicaniformes			
American White Pelican	Pelecanus erythrorhynchos		3
Double-Crested Cormorant	Phalacrocorax auritus		2
Family Podicipediformes			
Eared Grebe	Podiceps nigricollis	√	2
Pied-Billed Grebe	Podilymbus podiceps		2
Horned Grebe	Podiceps auritus		2
Western Grebe	Aechmophorus occidentalis	√	2
Family Ciconiformes			
American Bittern	Botaurus lentiginosus		2
Black-Crowned Night-Heron	Nycticorax nycticorax		2
Great Blue Heron	Ardea herodias		3
Green Heron	Butorides striatus		2
Cattle Egret	Bubulcus ibis		2
Snowy Egret	Egretta Thula		2
White-Faced Ibis	Plegadis chihi	√	2
Turkey Vulture	Cathartes aura		3
Family Alcedinidae			
Belted Kingfisher	Ceryl alcyon		2
Gulls, Terns and Shorebirds - omnivorous diet			
Family Charadriformes			
Black Tern	Chlidonias niger		2
Bonaparte’s Gull	Larus philadelphia		2
California Gull	Larus californicus	√	2
Caspian Tern	Sterna Caspia		2
Common Tern	Sterna hirundo		2
Forster’s Tern	Sterna forsteri		2
Franklin’s Gull	Larus pipixcan	√	2
Herring Gull	Larus argentatus		2
Ring-Billed Gull	Larus delawarensis	√	2
American Avocet	Recurvirostra americana		2
American Dipper	Cinclus mexicanus		2
Baird’s Sandpiper	Calidris bairdii		2
Black-Bellied Plover	Pluvialis squatarola		2
Black-Necked Stilt	Himantopus mexicanus		2
Common Snipe	Gallinago gallinago	√	2
Greater Yellowlegs	Tringa melanoleuca		2
Killdeer	Charadrius vociferus	√	2
Least Sandpiper	Calidris minutilla		2
Lesser Golden-Plover	Pluvialis dominica		2
Lesser Yellowlegs	Tringa flavipes		2
Long-Billed Curlew	Numenius americanus		2
Long-Billed Dowitcher	Limnodromus scolopaceus		2
Short-Billed Dowitcher	Limnodromus griseus		2
Solitary Sandpiper	Tringa solitaria		2
Spotted Sandpiper	Actitis macularia		2

Tables A4-12
Regional Birds

Common Name	Species Name	Sampled	Trophic Level
Stilt Sandpiper	Micropalma himantopus		2
Upland Sandpiper	Bartramia longicauda		2
Western Sandpiper	Calidris mauri		2
Willett	Catoptrophorus semipalmatus	√	2
Wilson’s Phalarope	Phalaropus tricolor		2
Marbled Godwit	Limosa Fedoa		2
Marsh Birds - omnivorous diet			
Family Gruiformes			
Sora	Porzana carolina		2
Virginia Rail	Rallus limicola		2
Whooping Crane	Grus americana		2
Greater Sandhill Crane	Grus canadensis	√	2
American Coot	Fulica americana	√	2
Swans, Geese and Ducks - omnivorous diet			
Family Anseriformes			
American Wigeon	Anas americana		2
Barrow’s Goldeneye	Bucephala islandica		2
Blue-Winged Teal	Anas discors		2
Canvasback	Aythya valisineria		2
Cinnamon Teal	Anas cyanoptera	√	2
Common Goldeneye	Bucephala clangula		2
Common Merganser	Mergus merganser		2
Gadwall	Anas strepera		2
Common Teal	Anas crecca		2
Green-Winged Teal	Anas carolinensis		2
Hooded Merganser	Lophodytes cucullatus		2
Canada Goose	Branta canadensis	√	2
Lesser Scaup	Aythya affinis		2
Mallard	Anas platyrhynchas	√	2
Northern Shoveler	Anas Clypeata		2
Red-Breasted Merganser	Mergus serrator		2
Redhead Duck	Aythya americana		2
Ruddy Duck	Oxyura jamaicensis		2
Trumpeter Swan	Cygnus buccinator		1
Tundra Swan	Cygnus columbianus		1
Northern Pintail	Anas acuta		2
Greater Scaup	Aythya marila		2
Bufflehead	Bucephala albeola		2

Tables A4-12 Regional Birds			
Common Name	**Species Name**	**Sampled**	**Trophic Level**
Hawks and Owls - carnivorous diet			
Family Falconiformes			
American Kestrel	Falco sparverius	√	3
Coopers Hawk	Accipiter cooperii		3
Ferruginour Hawk	Buteo regalis		3
Golden Eagle	Aquila chrysuetos		3
Marsh Hawk	Circus cyaneus		3
Northern Goshawk	Accipiter gentilis		3
Northern Harrier	Circus cyaneus		3
Peregrine Falcon	Peregrinus anatum		3
Prairie Falcon	Falco mexicanus		3
Red-Tailed Hawk	Buteo jamaicensis		3
Rough-Legged Hawk	Buteo lagopus		3
Sharp-Shinned Hawk	Accipiter striatus		3
Sparrow Hawk	Falco spariverius		3
Swainson's Hawk	Buteo swainsoni		3
Bald Eagle	Haliaeetus leucocephalus		3
Family Strigiformes			
Barn Owl	Tyto alba		3
Boreal Owl	Aegolius funereus		3
Burrowing Owl	Athene cunicularia		2
Common Nighthawk	Chordeiles minor		2
Common Poorwill	Phalaenoptilus nuttallii		2
Flammulated Owl	Otus flammeolus		2
Great Gray Owl	Strix nebulosa		3
Long-Eared Owl	Asio otus		3
Northern Pygmy-Owl	Glaucidium gnoma		3
Northern Saw-Whet Owl	Aegolius acadicus		3
Short-Eared Owl	Asio flammeus		3
Western Screech Owl	Otus kennicottii		3
Chicken-like Birds and Pigeons - herbivorous diet			
Family Galliformes			
Blue Grouse	Dendragapus obscuras		2
Columbian Sharp-Tailed Grouse	'ympanchus phasianellus columbianus		2
Gray-Partridge	Perdix perdix		1
Hungarian Partridge	Perdix perdix		2
Ring-Necked Pheasant	Phasianus colchicus		2
Ruffed Grouse	Bonasa umbellus		2
Sage Grouse	Centrocercus urophasianus		2
Sharp-Tailed Grouse	Pedioecetes phasianellus		2
Family Columbidae			
Mourning Dove	Zenaida macroura		1
Rock Dove	Columa livia		1
Hummingbirds - Nectar diet			
Family Trochilidae			
Black-Chinned Hummingbird	Archilochus alexandri		2
Broad-Tailed Hummingbird	Selasphorus platycercus		2
Calliope Hummingbird	Stellula calliope		2
Rufous Hummingbird	Selasphorus rufus		2

Tables A4-12 Regional Birds			
Common Name	**Species Name**	**Sampled**	**Trophic Level**
Woodpeckers - insectivore diet			
Family Picidae			
Black-Backed Woodpecker	Picoides villosus		2
Hairy Woodpecker	Picoides villosus		2
Northern Flicker	Colaptes auratus	√	2
Red-Naped Sapsucker	Sphyrapicus varius		2
Red-Shafted Flicker	Colaptes cafer		2
Williamson's Sapsucker	Sphyrapicus thyroideus		2
Downy Woodpecker	Dendrocopos pubescens		2
Songbirds (omnivorous diet unless otherwise specified)			
Family Fringillidae - herbivore diet			
Pine Grosbeak	Pinicola enucleator		1
Evening Grosbeak	Hesperiphona vespertina		2
American Goldfinch	Carduelis tristis		1
Cassin's Finch	Carpodacus cassinnii		1
Common Redpoll	Carduelis flammea		2
Gray-Crowned Rosy Finch	Leucosticte atrata		2
House Finch	Carpodacus mexicanus		1
Pine Siskin	Carduelis pinus		1
Red Crossbill	Loxia curvirostra		1
White-Winged Crossbill	Loxia leucoptera		1
Family Bombycillidae - fruit diet			
Bohemian Waxwing	Bambycilla garrula		2
Cedar Waxwing	Bombycilla cedrorum		2
Family Picidae - Insectivore diet			
Cassin's Kingbird	Tyrannus vociferans		2
Dusky Flycatcher	Empidonax oberholseri		2
Eastern Kingbird	Tyrannus tyrannus		2
Gray Flycatcher	Empidonax wrightii		2
Hammond's Flycatcher	Empidonax hammondii		2
Olive-Sided Flycatcher	Nuttallornis borealis		2
Say's Phoebe	Sayornis saya		2
Western Kingbird	Tyrannus verticalis		2
Western Wood-Peewee	Contopus sordidulus		2
Willow Flycatcher	Empidonax traillii		2
Family Hirundinidae - Insectivore diet			
Bank Swallow	Riparia riparia	√	2
Barn Swallow	Hirundo rustica		2
Cliff Swallow	Hirundo pyrrhonota	√	2
Northern Rough-Winged Swallow	Stelgidopteryx ruficollis		2
Rough-Winged Swallow	Stelgidopteryx serrupennis		2
Tree Swallow	Tachycineta bicolor	√	2
Violet-Green Swallow	Tachycineta thalassina		2
Family Regulidae - Insectivore diet			
Golden-Crowned Kinglet	Regulus satrapa		2
Ruby-Crowned Kinglet	Regulus calendula		2
Family Sylviidae - Insectivore diet			
Blue-Gray Gnatcatcher	Polioptila caerulea		2
Family Cinclidae - Insectivore diet			
Dipper	Cinclus mexicanus		2

Tables A4-12 Regional Birds			
Common Name	**Species Name**	**Sampled**	**Trophic Level**
Family Troglodytidae - Insectivore diet			
House Wren	Troglodytes aedon	√	2
Marsh Wren	Cistothorus palustris	√	2
Rock Wren	Salpinctes obsoletus		2
Family Turdidae - Insectivore diet			
American Robin	Turdus migratorius	√	2
Hermit Thrush	Catharus guttatus		2
Mountain Bluebird	Sialia currucoides	√	2
Swainson’s Thrush	Catharus ustulatus		2
Townsend’s Solitaire	Myadestes townsendi		2
Veery	Catharus fuscescens		2
Western Bluebird	Silalia mexicana		2
Family Parulidae - Insectivore diet			
American Redstart	Setophaga ruticilla		2
Black-Throated Gray Warbler	Dendroica nigrescens		2
Common Yellowthroat	Geothlypis trichas		2
MacGillivray’s Warbler	Oporornis tolmiei		2
Nashville Warbler	Vermivora ruficapilla		2
Northern Waterthrush	Seiurus noveboracensis		2
Orange-Crowned Warbler	Vermivora celata		2
Townsend’s Warbler	Dendroica townsendi		2
Virginia’s Warbler	Vermivora virginiae		2
Wilson’s Warbler	Wilsonnia pusilla		2
Yellow Warbler	Dendroica petechia	√	2
Yellow-Breasted Chat	Chat Icteria virens		2
Yellow-Rumped Warbler	Dendroica coronata		2
Family Corvidae			
American Crow	Corvus brachyrhynchos		2
Black-Billed Magpie	Pica pica		2
Clark’s Nutcracker	Nucifraga columbiana		2
Common Crow	Corrus brachyrhnchos		2
Common Raven	Corvus coraz		2
Gray Jay	Perisoreus canadensis		2
Horned Lark	Eremophilia alpestris		2
Steller’s Jay	Cyanocitta stelleri		2
Family Vireonidae			
Red-Eyed Vireo	Vireo olivaceus		2
Solitary Vireo	Vireo solitarius		2
Warbling Vireo	Vireo gilvus		2
Family Laniidae			
Loggerhead Shrike	Lanius ludovicianus		2
Family Paridae			
Black-Capped Chickadee	Parus atricapillus		2
Bushtit	Psaltriparus minimus		2
Mountain Chickadee	Parus gambeli		2
Plain Titmouse	Parus inornatus		2
Family Sittidae			
Red-Breasted Nuthatch	Sitta canadensis		2
White-Breasted Nuthatch	Sitta carolinensis		2
Family Certhiidae			
Brown Creeper	Certhia familiaris		2

Tables A4-12 Regional Birds			
Common Name	**Species Name**	**Sampled**	**Trophic Level**
Family Mimidae			
Gray Catbird	Dumetella carolinensis		2
Sage Thrasher	Oreoscoptes montanus		2
Family Sturnidae			
European Starling	Sturnus vulgaris	√	2
Family Thraupidae			
Western Tanager	Piranga ludoviciana		2
Family Cardinalidae			
Black-Headed Grosbeak	Pheucticus melanocephalus		2
Lazuli Bunting	Passerina amoena		2
Family Emberizidae			
American Tree Sparrow	Spizella arborea		2
Brewer’s Sparrow	Spizella Breweri		2
Chipping Sparrow	Spizella passerina		1
Dark-Eyed Junco	Junco hyemalis		2
Fox Sparrow	Passerella iliaca		2
Grasshopper Sparrow	Ammodramus savannarum		2
Lark Bunting	Calamospiza melanocorys		2
Green-Tailed Towhee	Chlorura chlorara		2
Horned Sparrow	Passer domesticus		2
Lark Sparrow	Chondestes grammacus		2
Lincoln’s Sparrow	Melospiza lincolnii		2
Rufous-Sided Towhee	Pipilo erythrophthalmus		2
Sage Sparrow	Amphispiza belli		2
Savannah Sparrow	Passerculus sandwichensis		2
Song Sparrow	Melospiza melodia	√	2
Vesper Sparrow	Pooecetes gramineus		2
White-Crowned Sparrow	Zonotrichia leucophrys		2
Family Icteridae			
Brewer’s Blackbird	Euphagus cyanocephalus	√	2
Brown-Headed Cowbird	Molothrus ater	√	2
Common Grackle	Quiscalus quiscula		2
Northern Oriole	Icterus galbula		2
Red-Winged Blackbird	Agelaius phoeniceus	√	2
Western Meadowlark	Sturnella neglecta		2
Yellow-Headed Blackbird	Xanthocephalus xanthocephalus	√	2
Family Passeridae			
House Sparrow	Passer domesticus		2

Sources:
Idaho Conservation Data Center (1999); List of Birds (Updated August 1997) as cited in MW, 1999.
Riparian Community Type Classification of Eastern Idaho-Western Wyoming (Youngblood, Padgett, and Winward, 1985).
Distribution, Season of Use, and Habitat of the Mammals, Birds, Reptiles, Amphibians, and Fishes of Idaho (Wilson, 1977).
Ecological Site Inventory for Pocatello Resource Area, Bureau of Land Management (Undated).

Table A4-13
Regional Mammals

Common Name	Species Name	Sampled	Trophic Level
<u>Order Insectivora - Invertebrate diet</u>			
Family Soricidae (Shrews)			
Merriam's Shrew	Sorex merriami		2
<u>Order Rodentia (Rodents) - Omnivorous diet</u>			
Family Sciuridae (Chipmunks, Marmots, & Squirrels)			
Golden-Mantled Squirrel	Citellus lateralis		1
Richardson Ground Squirrel	Citellus richardsoni		1
Townsend's Ground Squirrel	Spermophilus townsendii		2
Uinta Ground Squirrel	Citellus armatus	√	2
Rock Squirrel	Spermophilus variegatus		2
Least Chipmunk	Etuamias minimus	√	1
Uinta Chipmunk	Tamius umbrinus		1
Yellow Pine Chipmunk	Eutamias amoenus		1
Yellow-Bellied Marmot	Marmota flaviventris		1
Family Muridae (Mice, Rats, Lemmings, & Voles)			
Deer Mouse	Peromyscus maniculatus	√	2
House Mouse	Mus musculus		1
Northern Grasshopper Mouse	Onychomys leucogaster		2
Western Harvest Mouse	Reithrodontomys megalotis	√	2
Long-Tailed Vole	Microtus longieaudus		1
Mountain Vole	Microtus montanus		2
Muskrat	Ondatra zibethica		2
Bushy-Tailed Wood Rat	Neotoma cinera		1
Family Geomyidae (Pocket Gophers)			
Idaho Pocket Gopher	Thomomys idahoensis		1
Northern Pocket Gopher	Thomomys talpoides		2
Family Heteromyidae (Pocket Mice, Kangaroo Mice, & Kangaroo Rats)			
Great Basin Pocket Mouse	Perognathus parvus		2
Family Castoridae (Beaver)			
Beaver	Castor canadensis		1
Family Erethizontidae (Porcupines)			
Porcupine	Erethizone dorsatum		1
<u>Order Carnivora - Carnivorous diet</u>			
Family Canidae (Coyotes, Dogs, Foxes, Jackals, and Wolves)			
Coyote	Canis latrans		3
Gray Wolf	Canis lupus		3
Red Fox	Vulpes vulpes		2
Family Felidae (Cats)			
Mountain Lion	Felis concolor		3
Bobcat	Lynx rufus		3
Family Ursidae (Bears)			
Black Bear	Ursus americanus		3
Family Procyonidae (Coatis, Raccoons, and relatives)			
Raccoon	Procyon lotor		2
Family Mustelidae (Badgers, Otters, Weasels, and relatives)			
Badger	Taxidea taxus		3
Mink	Mustea vison		3

Table A4-13
Regional Mammals

Common Name	Species Name	Sampled	Trophic Level
Long-Tailed Weasel	Mustela frenata		2
Short-Tailed Weasel (ermine)	Mustela erminea		3
Striped Skunk	Mephitis mephitis		2
Wolverine	Gulo gulo		2
Order Chiroptera (Bats) - Insect diet			
Family Vespertilionidae (Evening bats and Vesper bats)			
Big Brown Bat	Eptesicus fucus		2
Hoary Bat	Lasiurus cinereus		2
Pallid Bat	Antrozous pallidus		2
Silver-Haired Bat	Lasionycteris noctivagans		2
Townsend’s Big-Eared Bat	Plecotus townsendii		2
Little Brown Myotis	Myotis lucifugus		2
Long-Eared Myotis	Myotis evotis		2
Long-Legged Myotis	Myotis volans		2
Western Small-footed Myotis	Myotis ciliolabrum		2
Yuma Myotis	Myotis yumanenisis		2
Order Lagomorpha (Pikas, Hares, and Rabbits) - Herbivorous diet			
Family Leporidae (Hares and Rabbits)			
Snowshoe Hare	Lepus americanus		1
Black-Tailed Jack Rabbit	L. californicus		1
Pygmy Rabbit	Brachylagus idahoensis		1
White-Tailed Jack Rabbit	Lepus townsendii		1
Mountain Cottontail	Sylvilagus nuttallii		1
Order Artiodactyla (Hoofed Mammals) - Herbivorous diet			
Family Cervidae (Deer)			
Mule Deer	Odocoileus hemionus		1
White-Tailed Deer	Odocoileus virginianus		1
Elk	Cervus elaphus	√	1
Moose	Alces alces		1

Sources:
Idaho Conservation Data Center (1999); List of Mammals (Updated March 1998) as cited in MW, 1999.
Distribution, Season of Use, and Habitat of the Mammals, Birds, Reptiles, Amphibians and Fishes of Idaho (Wilson, 1977).

Table A4-14
Assessment Endpoints and Indicator Receptors

			Measures of	
Feeding Guild	Assessment Endpoint	Receptor	Exposure	Effect
2 ˚ Consumers Amphipians and Fish	Protect amphibians and fish from acute and chronic adverse effects from direct and/or secondary exposure to metals resulting from phosphate mining activities.	Frog; Trout	Measured surface water COPEC concentrations	· Compare measured surface water concentration with acceptable levels
1 ˚ Consumers Terrestrial Herbivore	Protect herbivorous mammals (avian and terrestrial predator prey items) by limiting acute and chronic adverse effects from exposure to metals resulting from phosphate mining activities.	Long-tailed Vole	Calculated daily dosage using exposure models, measured chemical concentrations in abiotic and biotic media, and food web interactions.	· Compare calculated dose to NOAEL dosages for similar prey species.
	Protect large herbivorous mammals (game species) by limiting acute and chronic adverse effects from exposure to metals resulting from phosphate mining activities.	Elk	· Calculated daily dosage using exposure models, measured chemical concentrations in abiotic and biotic media, and food web interactions.	· Compare calculated dose to NOAEL dosages for similar species.
1 ˚ Consumers Avian Herbivore	Protect herbivorous bird species from acute and chronic adverse effects from direct and/or secondary exposure to metals resulting from phosphate mining activities.	American Goldfinch	· Calculate daily dosage using exposure models, measured chemical concentrations in abiotic and biotic media, and food web interactions.	· Compare calculated dose to NOAEL dosages for similar species.
2 ˚ Consumers Terrestrial Omnivore	Protect small omnivorous mammals (avian and terrestrial predator prey items) by limiting acute and chronic adverse effects from exposure to metals resulting from phosphate mining activities.	Deer Mouse	· Calculated daily dosage using exposure models, measured chemical concentrations in abiotic and biotic media, and food web interactions.	· Compare calculated dose to NOAEL dosages for similar species.

Table A4-14
Assessment Endpoints and Indicator Receptors

Feeding Guild	Assessment Endpoint	Receptor	Measures of Exposure	Measures of Effect
	Protect omnivorous mammals by limiting acute and chronic adverse effects from exposure to metals resulting from phosphate mining activities.	Raccoon	· Calculated daily dosage using exposure models, measured chemical concentrations in abiotic and biotic media, and food web interactions.	· Compare calculated dose to NOAEL dosages for similar prey species.
2 ˚ Consumers Avian Omnivore	Protect omnivorous bird species from acute and chronic adverse effects from direct and/or secondary exposure to metals resulting from phosphate mining activities.	American Robin	· Calculate daily dosage using exposure models, measured chemical concentrations in abiotic and biotic media, and food web interactions.	· Compare calculated dose to NOAEL dosages for similar species.
	Protect omnivorous water bird species from acute and chronic adverse effects from direct and/or secondary exposure to metals resulting from phosphate mining activities.	Mallard	· Calculate daily dosage using exposure models, measured chemical concentrations in abiotic and biotic media, and food web interactions.	· Compare calculated dose to NOAEL dosages for similar species.
3 ˚ Consumers Terrestrial Predator	Protect upper trophic level aquatic feeding terrestrial species from acute and chronic adverse effects from direct and/or secondary exposure to metals resulting from phosphate mining activities.	Mink	· Calculated daily dosage using exposure models, measured chemical concentrations in abiotic and biotic media, and food web interactions.	· Compare calculated dose to NOAEL dosages for similar prey species.

Table A4-14
Assessment Endpoints and Indicator Receptors

Feeding Guild	Assessment Endpoint	Receptor	Measures of Exposure	Measures of Effect
	Protect upper trophic level terrestrial species from acute and chronic adverse effects from direct and/or secondary exposure to metals resulting from phosphate mining activities.	Coyote	· Calculated daily dosage using exposure models, measured chemical concentrations in abiotic and biotic media, and food web interactions.	· Compare calculated dose to NOAEL dosages for similar prey species.
3 ˚ Consumers Avian Predator	Protect upper trophic level aquatic feeding avian species from acute and chronic adverse effects from direct and/or secondary exposure to metals resulting from phosphate mining activities.	Great Blue Heron	· Calculated daily dosage using exposure models, measured chemical concentrations in abiotic and biotic media, and food web interactions.	· Compare calculated dose to NOAEL dosages for similar prey species.
	Protect upper trophic level avian species from acute and chronic adverse effects from direct and/or secondary exposure to metals resulting from phosphate mining activities.	Northern Harrier	· Calculated daily dosage using exposure models, measured chemical concentrations in abiotic and biotic media, and food web interactions.	· Compare calculated dose to NOAEL dosages for similar prey species.

Notes:

COPEC - chemical of potential concern

NOAEL - no observed adverse effects level

Table A4-15
Terrestrial Bioaccumulation Factors for Use in Modeling Food Chain Exposure for Ecological Receptors

Chemicals of Potential Ecological Concern	Bioaccumulation Factors [a]					
	$BAF_{S\text{-}P}$		$BAF_{S\text{-}I}$		$BAF_{S\text{-}V}$	
	kg dry soil/ kg dry tissue	Source	kg dry soil/ kg dry tissue	Source	kg dry soil/ kg dry tissue	Source
Aluminum	NA [c]		NA [c]		NA [c]	
Antimony	Regression [b]	EcoSSL	1	EcoSSL	0.05	EcoSSL
Arsenic	0.03752	EcoSSL	Regression [b]	EcoSSL	Regression [b]	EcoSSL
Barium	NA [c]		NA [c]		NA [c]	
Boron	4.0	Baes 1984	1	Default	1	Default
Cadmium	Regression [b]	EcoSSL	Regression [b]	EcoSSL	Regression [b]	EcoSSL
Chromium	0.041	EcoSSL	0.306	EcoSSL	Regression [b]	EcoSSL
Cobalt	0.0075	EcoSSL	0.122	EcoSSL	Regression [b]	EcoSSL
Copper	Regression [b]	EcoSSL	0.515	EcoSSL	Regression [b]	EcoSSL
Manganese	0.079	EcoSSL	Regression [b]	EcoSSL	0.0205	EcoSSL
Mercury	Regression [b]	Bechtel Jacobs 1998b	Regression [b]	Sample 1998a	0.192	Sample 1998b
Molybdenum	0.25	Baes 1984	1	Default	1	Default
Nickel	Regression [b]	EcoSSL	1	Default	Regression [b]	EcoSSL
Selenium	Regression [b]	EcoSSL	Regression [b]	EcoSSL	Regression [b]	EcoSSL
Silver	0.014	EcoSSL	2.045	EcoSSL	0.004	EcoSSL
Thallium	0.0040	Baes 1984	1	Default	0.1124	Sample 1998b
Uranium	0.0085	Baes 1984	1	Default	1	Default
Vanadium	0.00485	EcoSSL	0.042	EcoSSL	0.0123	EcoSSL
Zinc	Regression [b]	EcoSSL	Regression [b]	EcoSSL	Regression [b]	EcoSSL

Notes:

[a] Soil bioaccumulation factors derived using the the soil to plant, soil to invertebrate and soil to animal bioaccumulation factor hierarchies presented in Section 4.2.2. As noted in Sectioni 4.2.2.1, when sufficient data were available, Site-specific plant tissue concentrations were used instead of plant tissue concentrations modeled using uptake factors.

[b] Equations and parameters for uptake regresssions are presented in Table A4-17.

[c] No terrestrial bioaccumulation factors provided because this analyte was not identified as chemical of potential ecological concern in soil, and was not analyzed for in sediment samples.

Table A4-15
Terrestrial Bioaccumulation Factors for Use in Modeling Food Chain Exposure for Ecological Receptors

	Bioaccumulation Factors [a]					
	BAF_{S-P}		BAF_{S-I}		BAF_{S-V}	
Chemicals of Potential Ecological Concern	**kg dry soil/ kg dry tissue**	**Source**	**kg dry soil/ kg dry tissue**	**Source**	**kg dry soil/ kg dry tissue**	**Source**

Sources

Baes 1984 - A review and analysis of parameters for assessing transport of environmentally released radionuclides through agriculture (Baes et al., 1984).

Bechtel Jacobs 1998b - Empirical models for the uptake of inorganic chemicals from soil by plants (Bechtel Jacobs, 1998b)

EcoSSL - Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs), Attachment 4-1: Exposure Factors and Bioaccumulation Models for Derivation of Wildlife Eco-SSLs (USEPA, 2007b).

Sample et al 1998a - Development and Validation of Bioaccumulation Models for Earthworms (Sample et al., 1998a)

Sample et al 1998b - Development and Validation of Bioaccumulation Models for Small Mammals (Sample et al., 1998b)

BAF_{S-I} - Bioaccumulation Factor - Soil to Terrestrial Invertebrate
BAF_{S-P} - Bioaccumulation Factor - Soil to Terrestrial Plant
BAF_{S-V} - Bioaccumulation Factor - Soil to Terrestrial Animal

foc - fraction organic carbon
kg - kilogram
kow - octanol-water partition coefficient
NA - not applicable

Table A4-16
Aquatic Bioaccumulation Factors for Use in Modeling Food Chain Exposure for Ecological Receptors

Chemicals of Potential Ecological Concern	Bioaccumulation Factors [a]											
	BAF_{Sed-P}		BAF_{sed-I}		BAF_{sed-F}		BAF_{W-P}		BAF_{W-I}		BAF_{W-F}	
	kg dry sed/ kg dry tissue	Source	kg dry sed/ kg dry tissue	Source	kg dry sed/ kg dry tissue	Source	L water/ kg dry tissue	Source	L water/ kg dry tissue	Source	L water/ kg dry tissue	Source
Aluminum	0.004	Baes 1984	5.4	USEPA 1999	1	Default	2,432	USEPA 1999	24,355	USEPA 1999	14	USEPA 1999
Antimony	Regression [c]	EcoSSL	1	EcoSSL	1	Default	4,307	USEPA 1999	42	USEPA 1999	200	USEPA 1999
Arsenic	0.03752	EcoSSL	Regression [c]	Bechtel Jacobs 1998a	0.012	PTI 1995	856	USEPA 1999	437	USEPA 1999	570	USEPA 1999
Barium	0.156	EcoSSL	0.091	EcoSSL	1	Default	759	USEPA 1999	1,198	USEPA 1999	3,165	USEPA 1999
Boron	4.0	Baes 1984	1	Default	1	Default	1	Default	1	Default	1	Default
Cadmium	Regression [c]	EcoSSL	Regression [c]	Bechtel Jacobs 1998a	0.79	PTI 1995	2,283	USEPA 1999	20,731	USEPA 1999	4,535	USEPA 1999
Chromium	0.041	EcoSSL	Regression [c]	Bechtel Jacobs 1998a	0.043	PTI 1995	12,866	USEPA 1999	17,970	USEPA 1999	95	USEPA 1999
Cobalt	0.0075	EcoSSL	0.122	EcoSSL	1	Default	1	Default	1	Default	1	Default
Copper	Regression [c]	EcoSSL	Regression [c]	Bechtel Jacobs 1998a	1	Default	1,580	USEPA 1999	22,271	USEPA 1999	3,550	USEPA 1999
Manganese	0.079	EcoSSL	Regression [c]	EcoSSL	1	Default	1	Default	1	Default	1	Default
Mercury	Regression [c]	Bechtel Jacobs 1998b	Regression [c]	Bechtel Jacobs 1998a	0.38	PTI 1995	1	Default	1	Default	1	Default
Molybdenum	0.25	Baes 1984	1	Default	1	Default	1	Default	1	Default	1	Default
Nickel	Regression [c]	EcoSSL	Regression [c]	Bechtel Jacobs 1998a	1	Default	178	USEPA 1999	168	USEPA 1999	390	USEPA 1999
Selenium	Regression [c]	EcoSSL	Regression [c]	EcoSSL	1	Default	5,387	USEPA 1999	7,559	USEPA 1999	645	USEPA 1999
Silver	0.014	EcoSSL	2.045	EcoSSL	1	Default	31,232	USEPA 1999	1,785	USEPA 1999	439	USEPA 1999
Thallium	0.0040	Baes 1984	5.4	USEPA 1999	1	Default	43,800	USEPA 1999	89,850	USEPA 1999	50,000	USEPA 1999
Uranium	0.0085	Baes 1984	1	Default	1	Default	1	Default	1	Default	1	Default
Vanadium	0.00485	EcoSSL	0.042	EcoSSL	1	Default	1	Default	1	Default	1	Default
Zinc	Regression [c]	EcoSSL	Regression [c]	Bechtel Jacobs 1998a	1.8	PTI 1995	6,351	USEPA 1999	27,422	USEPA 1999	10,295	USEPA 1999

Notes:

[a] Sediment and water bioaccumulation factors derived using the the sediment/water to plant and sediment/water to invertebrate bioaccumulation factor hierarchies presented in Section 4.2.2.3.

[b] RAIS 2013 - Online Risk Assessment Information System chemical-specific factors (http://rais.ornl.gov/cgi-bin/tools/TOX_search?select=chem_spef), accessed in July 2013 (RAIS, 2013)

[c] Equations and parameters for uptake regresssions are presented in Table A4-17.

Sources

Baes 1984 - A review and analysis of parameters for assessing transport of environmentally released radionuclides through agriculture (Baes et al., 1984).

Bechtel Jacobs 1998a - Biota-Sediment Accumulation Factors for Invertebrates (Bechtel Jacobs, 1998a)

Bechtel Jacobs 1998b - Empirical models for the uptake of inorganic chemicals from soil by plants (Bechtel Jacobs, 1998b)

EcoSSL - Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs), Attachment 4-1: Exposure Factors and Bioaccumulation Models for Derivation of Wildlife Eco-SSLs (USEPA, 2007b).

PTI 1995 - Bioaccumulation Factor Approach Analysis for metals and Polar Organic Compounds (PTI, 1995)

USEPA 1999 - Screening Level Ecological Risk Assessment Protocol for hazardous combustion facilities (USEPA, 1999).

BAF_{Sed-F} - Bioaccumulation Factor - Sediment to Fish
BAF_{Sed-I} - Bioaccumulation Factor - Sediment to Aquatic Invertebrate
BAF_{Sed-P} - Bioaccumulation Factor - Sediment to Aquatic Plant
BAF_{W-F} - Bioaccumulation Factor - Water to Fish
BAF_{W-I} - Bioaccumulation Factor - Water to Aquatic Invertebrate
BAF_{W-P} - Bioaccumulation Factor - Water to Aquatic Plant

foc - fraction organic carbon
kg - kilogram
kow - octanol-water partition coefficient
L - liter
NA - not applicable

Table A4-17
Summary of Input Parameters Used to Calculate Regression-based Bioaccumulation Models

Chemicals of Potential Ecological Concern	Soil to Terrestrial Plant Regression Model			Soil to Soil Invertebrate Regression Model			Soil to Mammal Regression Model			Sediment to Aquatic Plant Regression Model			Sediment to Aquatic Invertebrate Regression Model		
	B0	B1	Source	B0	B1	Source	B0	B1	Source	B0	B1	Source	B0	B1	Source
Antimony	-3.233	0.938	EcoSSL [a]	NA			NA			-3.233	0.938	EcoSSL [ac]	NA		
Arsenic	NA			-1.421	0.706	EcoSSL [a]	-4.847	0.8188	EcoSSL [a]	NA			-0.292	0.754	Bechtel Jacobs 1998a [b]
Cadmium	-0.475	0.546	EcoSSL [a]	2.114	0.795	EcoSSL [a]	-1.2571	0.4723	EcoSSL [a]	-0.475	0.546	EcoSSL [ac]	0.0395	0.692	Bechtel Jacobs 1998a [b]
Chromium	NA			NA			-1.4599	0.7338	EcoSSL [a]	NA			0.2092	0.365	Bechtel Jacobs 1998a [b]
Copper	0.668	0.394	EcoSSL [a]	NA			2.042	0.1444	EcoSSL [a]	0.668	0.394	EcoSSL [ac]	1.089	0.278	Bechtel Jacobs 1998a [b]
Manganese	NA			NA			NA			NA			-0.809	0.682	EcoSSL [ac]
Mercury	-0.958	0.538	Bechtel Jacobs 1998b [a]	-0.684	0.118	Sample 1998a [a]	NA			-0.958	0.538	Bechtel Jacobs 1998b [a]	-0.67	0.327	Bechtel Jacobs 1998a [b]
Nickel	-2.223	0.748	EcoSSL [a]	NA			-0.2462	0.4658	EcoSSL [a]	-2.223	0.748	EcoSSL [ac]	1.48	-0.425	Bechtel Jacobs 1998a [b]
Selenium	-0.677	1.104	EcoSSL [a]	-0.075	0.733	EcoSSL [a]	-0.4158	0.3764	EcoSSL [a]	-0.677	1.104	EcoSSL [ac]	-0.075	0.733	EcoSSL [ac]
Zinc	1.575	0.554	EcoSSL [a]	4.449	0.328	EcoSSL [a]	4.3632	0.0706	EcoSSL [a]	1.575	0.554	EcoSSL [ac]	1.80	0.208	Bechtel Jacobs 1998a [b]

Notes:

[a] Natural Log Regression Model: LN [Biota] = B0 + B1*LN[Soil or sediment]; where [Biota] and [Soil or sediment] are concentrations of analyte in biota tissue and soil/sediment, respectively.

[b] Regression model: LOG[Biota] = B0 + B1*LOG[Soil]; where [Biota] and [Soil or sediment] are concentrations of analyte in biota tissue and soil/sediment, respectively.

[c] Soil-to-biota regression-based bioaccumulation models only used for sediment to biota pathways when sediment-to-biota bioaccumulation models are unavailable.

Sources
Bechtel Jacobs 1998a - Biota-Sediment Accumulation Factors for Invertebrates (Bechtel Jacobs, 1998a)
Bechtel Jacobs 1998b - Empirical models for the uptake of inorganic chemicals from soil by plants (Bechtel Jacobs, 1998b)
EcoSSL - Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs), Attachment 4-1: Exposure Factors and Bioaccumulation Models for Derivation of Wildlife Eco-SSLs (USEPA, 2007b).
Sample et al 1998a - Development and Validation of Bioaccumulation Models for Earthworms (Sample et al., 1998a)

NA - Not applicable: bioaccumulation calculated based on an constant uptake factor, as presented in Table A4-15.

Table A4-18
Exposure Parameters for Ecological Receptors

Exposure Parameter	Long-Tailed Vole *Microtus longicaudus*	Elk *Cervus elaphus*	American Goldfinch *Spinus tristis*	Deer Mouse *Peromyscus maniculatus*	Raccoon *Procyon lotor*	American Robin *Turdus migratorius*	Mallard *Anas platyrhynchos*	Mink *Mustela vison*	Coyote *Canis latrans*	Great Blue Heron *Ardea herodias*	Northern Harrier *Circus cyaneus*
	Exposure Value										
Body Weight (g) [a]	37 [h,i]	2.9E+05 [k]	16 [m]	19.5 [h]	5,800 [h]	82.0 [h]	1,178 [h]	1,075 [h]	13,600 [p]	2,336 [h]	449 [t]
Fraction of Prey Items in Diet (%)											
Terrestrial											
Plant	100 [h,i]	100 [k]	100 [m]	61.5 [h]	64 [h]	44.7 [h]	0	0	2 [q]	0	0
Invertebrates	0	0	0	38.5 [h]	19 [h]	55.3 [h]	0	0	2 [q]	12.5 [o]	2 [t]
Mammals/Birds	0	0	0	0	9 [h]	0	0	63 [h]	96 [q]	12.5 [o]	98 [t]
Aquatic											
Plant	0	0	0	0	0	0	25.3 [h]	0	0	0	0
Invertebrates	0	0	0	0	7 [h]	0	74.7 [h]	6 [h]	0	0	0
Fish	0	0	0	0	1 [h]	0	0	31 [h]	0	75 [o]	0
Ingestion Rate of Prey (g dw/d) [b]	11.5	2,294	4.10	3.8	154	11	56	516	4,286	145	49
Soil/Sediment Ingestion Rate (g dw/d) [c]	0.276	45.9	0.426	0.076	14.5	1.10	1.86	48.51	120.01	1.0	0.34
Fraction of Upland Soil in the Diet (%)	2.4 [i,j]	2 [j]	10.4 [j,n]	2 [j,]	0	10.4 [j,n]	0	0	2.8 [j,n]	0	0.7 [s]
Fraction of Riparian Soil in the Diet (%)	0	0	0	0	9.40 [j]	0	0	9.4 [j,n]	0	0	0
Fraction of /Sediment in the Diet (%)	0	0	0	0	0	0	3.3 [j]	0	0	0.7 [s]	0
Water Ingestion Rate (L/d) [d]	0.00512	16.1	0.00362	0.00286	0.482	0.011	0.066	0.106	1.037	0.10	0.034
Home Range (acres)	0.0659 [h,i]	16,640 [l]	0.119 [o]	0.270 [h]	2,272 [h]	0.7 [h]	1,074 [h]	50 [h]	7,240 [r]	11 [h]	642 [t]
Area being Evaluated (acres) [e]	1,030	1,030	1,030	1,030	1,030	1,030	1,030	1,030	1,030	1,030	1,030
Site Utilization Factor (unitless) [f]	1	0.0619	1	1	0.453	1	0.959	1	0.142	1	1
Exposure Duration (percent of year) [g]	1	1	1 [m]	1	1	1	1	1	1	1	1

Notes:

[a] Average body weight for males and females combined.

[b] Calculated using Equations 25 (mink and coyote), 29 (elk), 33 (raccoon), 37 (passerines), 61 (American robin and mallard), and 63 (great blue heron and northern harrier) from Nagy (2001). The food ingestion rate for the long-tailed vole and deer mouse were based on values in Table 1 (Nagy, 2001) for meadow vole and deer mouse, respectively. The cattle food ingestion rate is based on beef cattle fodder intake rates from Risk Assessment Information System (RAIS) (2013).

[c] Calculated as percent soil ingestion rate multiplied by the food ingestion rate (g/d).

[d] Calculated using Equation 3-15 (all birds) and Equation 3-17 (all mammals) from USEPA, 1993.

[e] Exposure area for Henry Site is 1,030

[f] Site utilization factors are calculated as the exposure area divided by the home range. Instances where the home range > exposure area are reported as 1.

[g] Exposure duration (percent of year exposed) is assumed to be 1 for most species based on species range maps.

[h] Wildlife Exposure Factors Handbook (USEPA, 1993).

[i] Meadow vole used as a surrogate species.

[j] Soil ingestion rates as percent of diet from Beyer (1994).

[k] Senseman, R. 2002. "Cervus elaphus" (On-line), Animal Diversity Web. Accessed February 22, 2011 http://animaldiversity.ummz.umich.edu/site/accounts/information/Cervus_elaphus.html.

[l] An Evaluation of the Effects of Selenium on Elk, Mule Deer, and Moose in SE Idaho (Kuck, 2003a).

[m] From Cornell Lab of Ornithology web site (www.birds.cornell.edu).

[n] The American woodcock was used as a surrogates for the American goldfinch and American Robin. The white footed mouse was used as a surrogate for the deer mouse. The raccoon was used as a surrogate for the mink. The red fox was used as a surrogate for the coyote.

[o] Life history account from Zeiner, D.C. et al. (1988-1990). Maintained by California Wildlife Habitat Relationship Program of the California Department of Fish and Wildlife. Accessed at http://www.dfg.ca.gov/biogeodata/CWHR/cawildlife.aspx.

[p] Idaho digital atlas: http://imnh.isu.edu/digitalatlas/bio/mammal/mamfram.htm

[q] MacCracken and Hansen. 1982. Seasonal Foods of Coyotes in Southeastern Idaho: A Multivariate Analysis.

[r] Mean coyote homerange for southeastern Idaho from Woodruff and Keller (1982).

[s] Sediment ingestion percent for bald eagle from Pascoe et al. (1996) as cited in the Area Wide Risk Management Plan for the Southeast Idaho Phosphate Mining Resource Area (IDEQ, 2004) were used to calculate the sediment ingestion rate for the great blue heron and northern harrier.

[t] Northern harrier average body weight reported in Slater and Rock (2005).

% - percent
d – day
dw – dry weight
g – gram
L – liter

Table A4-19
Toxicity Reference Values for Mammalian Receptors

	TRV_{NOAEL}									TRV_{LOAEL}							
							UF									UF	
Analyte	Toxicity Value (mg/kg-day)	Test Species	Study Endpoint	Type	Effects	Source	LOAEL to NOAEL	Subchronic to Chronic	TRV_{NOAEL} (mg/kg-day)	Toxicity Value (mg/kg-day)	Test Species	Study Endpoint	Type	Effects	Source	Subchronic to Chronic	TRV_{LOAEL} (mg/kg-day)
Aluminum	1.93	Mouse	NOAEL	Chronic	Reproduction	ORNL 1996	1	1	1.93	19.3	Mouse	LOAEL	Chronic	Reproduction	ORNL 1996	1	19.3
Antimony	0.059	Rat	NOAEL	Chronic	Reproduction	EcoSSLs (Antimony)	1	1	0.0590	0.590	Rat	LOAEL	Chronic	Reproduction	EcoSSLs (Antimony)	1	0.590
Arsenic	1.04	Dog	NOAEL	Subchronic	Growth	EcoSSLs (Arsenic)	1	1	1.04	1.66	Dog	LOAEL	Subchronic	Growth	EcoSSLs (Arsenic)	1	1.66
Barium	51.8	Rat, Mouse	NOAEL	NA	Growth and Reproduction [a]	EcoSSLs (Barium)	1	1	51.8	121	Rat	LOAEL	Subchronic	Growth and Survival	EcoSSLs (Barium)	1	121
Boron	28.0	Rat	NOAEL	Chronic	Reproduction	ORNL 1996	1	1	28.0	93.6	Rat	LOAEL	Chronic	Reproduction	ORNL 1996	1	93.6
Cadmium	0.770	Rat	NOAEL	Subchronic	Growth	EcoSSLs (Cadmium)	1	1	0.770	0.909	Sheep	LOAEL	Subchronic	Growth	EcoSSLs (Cadmium)	1	0.909
Calcium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	2.40	Cattle, Mouse, Pig, Rat,	NOAEL	NA	Growth [b]	EcoSSLs (Chromium)	1	1	2.40	2.82	Rat	LOAEL	Subchronic	Survival	EcoSSLs (Chromium)	1	2.82
Cobalt	7.33	Cow, Guinea Pig, Mouse, Pig, Rat	NOAEL	NA	Growth and Reproduction [a]	EcoSSLs (Cobalt)	1	1	7.33	10.9	Rat	LOAEL	Subchronic	Reproduction	EcoSSLs (Cobalt)	1	10.9
Copper	5.60	Pig	NOAEL	Subchronic	Growth	EcoSSLs (Copper)	1	1	5.60	6.79	Mink	LOAEL	Subchronic	Reproduction	EcoSSLs (Copper)	1	6.79
Iron	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Magnesium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	51.5	Various	NOAEL	NA	Growth and Reproduction [a]	EcoSSLs (Manganese)	1	1	51.5	65.0	Cattle	LOAEL	Subchronic	Growth	EcoSSLs (Manganese)	1	65.0
Mercury	1.01	Mink	NOAEL	Chronic	Reproduction	ORNL 1996	1	1	1.01	--	--	--	--	--	--	--	--
Molybdenum	0.260	Mouse	NOAEL	Chronic	Reproduction	ORNL 1996	1	1	0.260	2.60	Mouse	LOAEL	Chronic	Reproduction	ORNL 1996	1	2.60
Nickel	1.70	Mouse	NOAEL	Subchronic	Reproduction	EcoSSLs (Nickel)	1	1	1.70	2.71	Mouse	LOAEL	Subchronic	Reproduction	EcoSSLs (Nickel)	1	2.71
Selenium	0.143	Pig	NOAEL	Subchronic	Growth	EcoSSLs (Selenium)	1	1	0.143	0.145	Mouse	LOAEL	Subchronic	Reproduction	EcoSSLs (Selenium)	1	0.145
Silver	60.2	Pig	LOAEL	Subchronic	Growth	EcoSSLs (Silver)	10	1	6.02	60.2	Pig	LOAEL	Subchronic	Growth	EcoSSLs (Silver)	1	60.2
Thallium	0.00740	Rat	NOAEL	Subchronic	Growth	ORNL 1996	1	2	0.00370	0.074	Rat	LOAEL	Subchronic	Growth	ORNL 1996	2	0.0370
Uranium	3.07	Mouse	NOAEL	Chronic	Reproduction	ORNL 1996	1	1	3.07	6.13	Mouse	LOAEL	Chronic	Reproduction	ORNL 1996	1	6.13
Vanadium	4.16	Mouse	NOAEL	Chronic	Growth	EcoSSLs (Vanadium)	1	1	4.16	5.11	Rat	LOAEL	Subchronic	Growth	EcoSSLs (Vanadium)	1	5.11
Zinc	75.4	Various	NOAEL	NA	Growth and Reproduction [a]	EcoSSLs (Zinc)	1	1	75.4	75.9	Cattle	LOAEL	Subchronic	Reproduction	EcoSSLs (Zinc)	1	75.9

Table A4-19
Toxicity Reference Values for Mammalian Receptors

	TRV_{NOAEL}									TRV_{LOAEL}							
							UF									UF	
Analyte	Toxicity Value (mg/kg-day)	Test Species	Study Endpoint	Type	Effects	Source	LOAEL to NOAEL	Subchronic to Chronic	TRV_{NOAEL} (mg/kg-day)	Toxicity Value (mg/kg-day)	Test Species	Study Endpoint	Type	Effects	Source	Subchronic to Chronic	TRV_{LOAEL} (mg/kg-day)

Notes:

[a] Geometric mean of NOAEL and LOAEL values for growth and reproduction were calculated as the TRV_{NOAEL} and TRV_{LOAEL} values, respectively.
[b] Geometric mean of NOAEL values for growth were calculated as the TRV_{NOAEL}.

Sources

EcoSSLs (Antimony) - Ecological Soil Screening Levels for Antimony (USEPA, 2005b).
EcoSSLs (Arsenic) - Ecological Soil Screening Levels for Arsenic (USEPA, 2005c).
EcoSSLs (Barium) - Ecological Soil Screening Levels for Barium (USEPA, 2005d).
EcoSSLs (Cadmium) - Ecological Soil Screening Levels for Cadmium (USEPA, 2005e).
EcoSSLs (Chromium) - Ecological Soil Screening Levels for Chromium (USEPA, 2008b).
EcoSSLs (Cobalt) - Ecological Soil Screening Levels for Cobalt (USEPA, 2005f).
EcoSSLs (Copper)- Ecological Soil Screening Levels for Copper (USEPA, 2007c).
EcoSSLs (Manganese) - Ecological Soil Screening Levels for Manganese (USEPA, 2007d).
EcoSSLs (Nickel) - Ecological Soil Screening Levels for Nickel (USEPA, 2007e).
EcoSSLs (Selenium) - Ecological Soil Screening Levels for Selenium (USEPA, 2007f).
EcoSSLs (Silver) - Ecological Soil Screening Levels for Silver (USEPA, 2006).
EcoSSLs (Vanadium) - Ecological Soil Screening Levels for Vanadium (USEPA, 2005g)
EcoSSLs (Zinc) - Ecological Soil Screening Levels for Zinc (USEPA, 2007g).
ORNL 1996 - Toxicological Benchmarks for Wildlife: 1996 Revision (ORNL, 1996b)

-- not available
EcoSSLs - Ecological Soil Screening Levels
LOAEL - lowest observed adverse effect level
NA - not applicable
mg/kg-dry - milligrams per kilogram dry weight
NOAEL - no observed adverse effect level
TRV - toxicity reference value
UF - uncertainty factor

Table A4-20
Toxicity Reference Values for Avian Receptors

	TRV_{NOAEL}										TRV_{LOAEL}								
							UF										UF		
Analyte	Toxicity Value (mg/kg-day)	Test Species	Study Endpoint	Type	Effects	Source	Acute LD_{50} to chronic NOAEL	LOAEL to NOAEL	Subchronic to Chronic	TRV_{NOAEL} [a] (mg/kg-day)	Toxicity Value (mg/kg-day)	Test Species	Study Endpoint	Type	Effects	Source	Acute LD_{50} to chronic LOAEL	Subchronic to Chronic	TRV_{LOAEL} (mg/kg-day)
Aluminum	110	Ringed Dove	NOAEL	Chronic	Reproduction	ORNL 1996	1	1	1	110	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	2.24	Chicken	NOAEL	Chronic	Growth and Reproduction	EcoSSLs (Arsenic)	1	1	1	2.24	3.55	Chicken	LOAEL	Subchronic	Growth	EcoSSLs (Arsenic)	1	1	3.55
Barium	20.8	Chicken	NOAEL	Subchronic	Mortality	ORNL 1996	1	1	1	20.8	41.7	Chicken	LOAEL	Subchronic	Mortality	ORNL 1996	1	1	41.7
Boron	28.8	Mallard duck	NOAEL	Chronic	Reproduction	ORNL 1996	1	1	1	28.8	100	Mallard duck	LOAEL	Chronic	Reproduction	ORNL 1996	1	1	100
Cadmium	1.47	Chicken, Mallard duck	NOAEL	NA	Growth and Reproduction [a]	EcoSSLs (Cadmium)	1	1	1	1.47	2.37	Chicken	LOAEL	Subchronic	Reproduction	EcoSSLs (Cadmium)	1	1	2.37
Calcium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	2.66	Chicken, Duck, Turkey	NOAEL	NA	Growth and Reproduction [a]	EcoSSLs (Chromium)	1	1	1	2.66	2.78	Duck	LOAEL	Subchronic	Reproduction	EcoSSLs (Chromium)	1	1	2.78
Cobalt	7.61	Chicken and Duck	NOAEL	NA	Growth [b]	EcoSSLs (Cobalt)	1	1	1	7.61	7.80	Chicken	LOAEL	Subchronic	Growth	EcoSSLs (Cobalt)	1	1	7.80
Copper	4.05	Chicken	NOAEL	Chronic	Reproduction	EcoSSLs (Copper)	1	1	1	4.05	4.68	Turkey	LOAEL	Subchronic	Growth	EcoSSLs (Copper)	1	1	4.68
Iron	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Magnesium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	179	Chicken, Japanese Quail, Turkey	NOAEL	NA	Growth and Reproduction [a]	EcoSSLs (Manganese)	1	1	1	179	348	Chicken	LOAEL	Subchronic	Growth	EcoSSLs (Manganese)	1	1	348
Mercury	0.450	Japanese Quail	NOAEL	Chronic	Reproduction	ORNL 1996	1	1	1	0.45	0.900	Japanese Quail	LOAEL	Chronic	Reproduction	ORNL 1996	1	1	0.900
Molybdenum	3.50	Chicken	NOAEL	Chronic	Reproduction	ORNL 1996	1	1	1	3.50	35.3	Chicken	LOAEL	Chronic	Reproduction	ORNL 1996	1	1	35.3
Nickel	6.71	Chicken, Duck	NOAEL	NA	Growth and Reproduction [a]	EcoSSLs (Nickel)	1	1	1	6.71	11.5	Chicken	LOAEL	Subchronic	Growth	EcoSSLs (Nickel)	1	1	11.5
Selenium	0.290	Chicken	NOAEL	Subchronic	Survival	EcoSSLs (Selenium)	1	1	1	0.290	0.368	Chicken	LOAEL	Subchronic	Reproduction	EcoSSLs (Selenium)	1	1	0.368
Silver	20.2	Turkey	LOAEL	Subchronic	Growth	EcoSSLs (Silver)	1	10	1	2.02	20.2	Turkey	LOAEL	Subchronic	Growth	EcoSSLs (Silver)	1	1	20.2
Thallium	34.6	Starling	LD_{50}	Acute	Mortality	Schafer 1983	100	1	1	0.346	34.6	Starling	LD_{50}	Acute	Mortality	Schafer 1983	10	1	3.46
Uranium	16.0	Black duck	NOAEL	Subchronic	Mortality, body weight, blood chemistry, liver/kidney effects	ORNL 1996	1	1	1	16.0	--	--	--	--	--	--	--	--	--
Vanadium	0.344	Chicken	NOAEL	Subchronic	Growth	EcoSSLs (Vanadium)	1	1	1	0.344	0.413	Chicken	LOAEL	Subchronic	Reproduction	EcoSSLs (Vanadium)	1	1	0.413

Table A4-20
Toxicity Reference Values for Avian Receptors

Analyte	TRV_{NOAEL}: Toxicity Value (mg/kg-day)	TRV_{NOAEL}: Test Species	TRV_{NOAEL}: Study Endpoint	TRV_{NOAEL}: Type	TRV_{NOAEL}: Effects	TRV_{NOAEL}: Source	TRV_{NOAEL}: UF: Acute LD_{50} to chronic NOAEL	TRV_{NOAEL}: UF: LOAEL to NOAEL	TRV_{NOAEL}: UF: Subchronic to Chronic	TRV_{NOAEL}[a] (mg/kg-day)	TRV_{LOAEL}: Toxicity Value (mg/kg-day)	TRV_{LOAEL}: Test Species	TRV_{LOAEL}: Study Endpoint	TRV_{LOAEL}: Type	TRV_{LOAEL}: Effects	TRV_{LOAEL}: Source	TRV_{LOAEL}: UF: Acute LD_{50} to chronic LOAEL	TRV_{LOAEL}: UF: Subchronic to Chronic	TRV_{LOAEL} (mg/kg-day)
Zinc	66.1	Chicken, Mallard duck, Japanese Quail, Turkey	NOAEL	NA	Growth and Reproduction [a]	EcoSSLs (Zinc)	1	1	1	66.1	66.5	Chicken	LOAEL	Subchronic	Reproduction	EcoSSLs (Zinc)	1	1	66.5

Notes:
[a] Geometric mean of NOAEL and LOAEL values for growth and reproduction were calculated as the TRV_{NOAEL} and TRV_{LOAEL} values, respectively.
[b] Geometric mean of NOAEL values for growth were calculated as the TRV_{NOAEL}.

Sources
EcoSSLs (Antimony) - Ecological Soil Screening Levels for Antimony (USEPA, 2005b).
EcoSSLs (Arsenic) - Ecological Soil Screening Levels for Arsenic (USEPA, 2005c).
EcoSSLs (Cadmium) - Ecological Soil Screening Levels for Cadmium (USEPA, 2005e).
EcoSSLs (Chromium) - Ecological Soil Screening Levels for Chromium (USEPA, 2008b).
EcoSSLs (Cobalt) - Ecological Soil Screening Levels for Cobalt (USEPA, 2005f).
EcoSSLs (Copper)- Ecological Soil Screening Levels for Copper (USEPA, 2007c).
EcoSSLs (Manganese) - Ecological Soil Screening Levels for Manganese (USEPA, 2007d).
EcoSSLs (Nickel) - Ecological Soil Screening Levels for Nickel (USEPA, 2007e).
EcoSSLs (Selenium) - Ecological Soil Screening Levels for Selenium (USEPA, 2007f).
EcoSSLs (Silver) - Ecological Soil Screening Levels for Silver (USEPA, 2006).
EcoSSLs (Vanadium) - Ecological Soil Screening Levels for Vanadium (USEPA, 2005g)
EcoSSLs (Zinc) - Ecological Soil Screening Levels for Zinc (USEPA, 2007g).
ORNL 1996 - Toxicological Benchmarks for Wildlife: 1996 Revision (ORNL, 1996b)
Schafer 1983 - The acute oral toxicity, repellency, and hazard potential of 998 chemicals to one or more species of wild and domestic birds (Schafer et al., 1983).

EcoSSLs - Ecological Soil Screening Levels
LC_{50} - lethal concentration to 50% of test population
LOAEL - lowest observed adverse effect level
NA - not applicable
mg/kg-dry - milligrams per kilogram dry weight
NOAEL - no observed adverse effect level
TRV - toxicity reference value
UF - uncertainty factor

Table A4-21
Ecological Hazard Calculations for Amphibians and Fish
Henry Site

Constituent	Surface Water EPC[a] (mg/L)	National Standards Aquatic Life [b] (mg/L)	Tier II Secondary Chronic Value [c] (mg/L)	Final Water Quality Criteria [d]	Ecological HQ
Aluminum	0.905	0.087	--	0.087	**10**
Barium	0.0810	--	0.0040	0.0040	**20**
Boron	0.121	--	0.0016	0.0016	**76**
Cadmium	0.0352	0.00047 [e]	--	0.00047	**75**
Cobalt	0.0141	--	0.023	0.023	0.61
Manganese	2.44	--	0.12	0.12	**20**
Nickel	1.26	0.12 [e]	--	0.12	**11**
Selenium	0.970	0.0031 [f]	--	0.0031	**313**
Uranium	0.0206	--	0.0026	0.0026	**7.9**
Vanadium	0.0885	--	0.02	0.020	**4.4**
Zinc	4.73	0.26 [e]	--	0.26	**18**

Notes:

[a] The surface water exposure point concentrations are equal to the maximum detected concentration measured in samples collected from upstream and downstream surface water stations

[b] National Recommended Water Quality Criteria (USEPA, 2013b); Freshwater Criterion Continuous Concentration (CCC) listed for all analytes except for silver. Only a Criterion Maximum Concentration (CMC) is available for silver.

[c] Tier II Secondary Chronic Value. Source: ORNL, 1996a.

[d] The final water quality criteria were obtained from the following hierarchy: 1) National Recommended Water Quality Criteria (USEPA, 2013b) and 2) Tier II Secondary Chronic Value

[e] The freshwater criterion for this metal is expressed as a function of hardness in the water column. The value given here corresponds to a hardness of 256 mg calcium carbonate per L water, which is the lowest average hardness for Henry Site streams and ponds. Criteria values for other hardness may be calculated from the following: CMC (dissolved) = exp {mA[ln(hardness)]+bA} (CF), or CCC (dissolved) = exp {mC[ln(hardness)]+bC} (CF) and the parameters specified in Appendix B of National Recommended Water Quality Criteria (USEPA, 2015b).

[f] New criteria developed in 2016 are 0.0015 mg/L for lentic systems, and 0.0031 mg/L for lotic systems. Although aquatic habitat at the Henry Site is generally lotic, and therefore the applicable final water quality criterion presented here is 0.0031 mg/L.

"- -" - not available
EPC - exposure point concentration
HQ - hazard quotient
mg/L - milligrams per liter

Table A4-22
Summary of Tier I Henry Site Hazard Estimates for Ecological Receptors

	EPC [a]				Ecological Hazard Estimates (HQ)										
	Upland Soil (mg/kg)	**Riparian Soil (mg/kg)**	**Surface Water (mg/L)**	**Sediment (mg/kg)**	**Long-Tailed Vole[b]**	**Elk[b]**	**American Goldfinch[b]**	**Deer Mouse[b]**	**Raccoon[b]**	**American Robin[b]**	**Mallard**	**Mink**	**Coyote[b]**	**Great Blue Heron**	**Northern Harrier**
					NOAEL-Based Ecological Hazard Estimates										
Aluminum	NA	NA	0.905	NA	0.065	0.0016	0.0019	0.069	**9.6**	0.0011	**7.1**	**329**	0.0051	0.0056	0.00063
Antimony	9.15	7.00	0.00230	8.50	**3.9**	0.0059	na	**13**	0.57	na	na	**12**	0.68	na	na
Arsenic	45.5	NA	0.0224	10.6	**3.4**	0.0053	**1.8**	**1.6**	0.0039	0.65	0.056	**1.9**	0.074	0.27	0.027
Barium	NA	NA	0.0810	NA	0.00022	0.0000054	0.00091	0.00023	0.0022	0.00052	0.19	0.79	0.000017	0.58	0.00030
Boron	39.0	5.90	0.121	17.4	0.53	0.00087	0.47	0.31	0.0081	0.21	0.050	0.092	0.065	0.0038	0.15
Cadmium	59.5	67.3	0.0352	104	**2.8**	0.0045	**2.1**	**22**	0.88	**11**	0.81	**37**	0.46	**6.4**	0.49
Chromium	519	467	0.00760	1,030	**3.9**	0.0059	**7.2**	**6.7**	0.43	**7.3**	1.0	**12**	0.75	0.66	**1.2**
Cobalt	NA	NA	0.0141	10.6	0.00026	0.0000067	0.00043	0.00028	0.00022	0.00025	0.0061	0.0055	0.000021	0.00017	0.00014
Copper	172	56.0	0.00379	68.8	**1.1**	0.0017	**2.2**	**1.6**	0.043	**2.4**	0.39	**1.8**	0.18	0.24	0.50
Manganese	NA	NA	2.4	2,580	0.007	0.0002	0.003	0.007	0.003	0.002	0.12	0.06	0.0005	0.008	0.0010
Mercury	0.503	0.0240	ND	0.236	0.025	0.000039	0.071	0.045	0.0013	0.098	0.016	0.019	0.0052	0.015	0.026
Molybdenum	35.7	14.8	0.0400	10.8	**149**	0.24	**9.7**	**69**	0.86	**2.9**	0.12	**21**	**6.6**	0.068	**1.1**
Nickel	425	251	1.26	1,110	**5.1**	0.010	**2.5**	**21**	0.60	**5.6**	0.30	**52**	0.89	**3.8**	0.41
Selenium	318	45.0	0.970	148	**333**	0.55	**164**	**166**	**5.1**	**60**	**16**	**679**	**5.9**	**101**	**3.7**
Silver	7.30	NA	ND	2.16	0.017	0.000026	0.12	0.19	0.00066	0.58	0.077	0.075	0.0040	0.050	0.020
Thallium	2.31	0.223	0.000348	2.17	**64**	0.10	0.73	**73**	**1.3**	0.69	0.23	**722**	**4.5**	**2.4**	0.099
Uranium	74.4	1.66	0.0206	90.0	0.31	0.00047	0.15	**2.0**	0.027	0.40	0.20	1.0	**1.1**	0.0042	0.51
Vanadium	584	773	0.0885	940	**2.0**	0.0030	**57**	**1.4**	0.25	**30**	**8.3**	**9.4**	0.26	**2.2**	**3.7**
Zinc	1,610	1,600	4.73	7,940	**1.1**	0.0020	**1.6**	**1.4**	0.17	**1.6**	0.52	**98**	0.12	**35**	0.27
				Ecological Hazard Criterion:	1	1	1	1	1	1	1	1	1	1	1

Notes:

[a] The abiotic media exposure point concentrations used in the Tier I Ecological Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at the Henry Site.

[b] Ecological dose and HQ estimates for terrestrial and riparian herbivorous and omnivorous species preferentially used the maximum detected COPEC concentration measured in upland and riparian vegetation from Henry Site sampling locations, where available, over plant tissue concentrations modeled from abiotic media.

Bold indicates exceedance of IDEQ's and USEPA's acceptable ecological hazard criterion

COPEC - constituent of potential ecological concern
EPC - exposure point concentration
HQ - Hazard quotient
IDEQ - Idaho Department of Environmental Quality

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
NA - not applicable
na - not available

ND - not detected
NOAEL - no observed adverse effects level
USEPA - U. S. Environmental Protection Agency

Table A4-23
Summary of Tier I Background Hazard Estimates for Ecological Receptors

	EPC [a]				Ecological Hazard Estimates (HQ)										
	Upland Soil (mg/kg)	Riparian Soil (mg/kg)	Surface Water (mg/L)	Sediment (mg/kg)	Long-Tailed Vole[b]	Elk[b]	American Goldfinch[b]	Deer Mouse[b]	Raccoon[b]	American Robin[b]	Mallard	Mink	Coyote[b]	Great Blue Heron	Northern Harrier
					NOAEL-Based Ecological Hazard Estimates										
Aluminum	NA	NA	0.410	NA	0.029	0.00074	0.00087	0.031	**4.4**	0.00050	**3.2**	**149**	0.0023	0.0025	0.00029
Antimony	3.60	5.50	NA	5.00	**29**	0.046	na	**16**	0.43	na	na	**21**	0.34	na	na
Arsenic	19.0	NA	0.00110	4.55	0.35	0.00052	0.32	0.29	0.0014	0.19	0.028	0.13	0.029	0.014	0.012
Barium	NA	NA	0.0850	NA	0.00023	0.0000057	0.00095	0.00024	0.0023	0.00055	0.20	0.83	0.000018	0.60	0.00031
Boron	25.0	11.2	0.0200	8.40	0.76	0.0012	0.65	0.36	0.014	0.21	0.024	0.15	0.043	0.0062	0.095
Cadmium	44.0	4.40	0.000100	3.74	**1.2**	0.0018	**1.2**	**17**	0.099	**8.7**	0.078	0.67	0.36	0.16	0.39
Chromium	420	42.5	0.00393	34.8	**3.5**	0.0053	**6.0**	**5.6**	0.042	**6.0**	0.10	**1.4**	0.62	0.061	1.0
Copper	82.0	21.1	ND	25.5	0.72	0.0011	**1.3**	0.86	0.025	**1.2**	0.29	**1.6**	0.14	0.34	0.42
Manganese	NA	NA	0.0484	405	0.00013	0.0000033	0.000063	0.00014	0.00047	0.000036	0.028	0.015	0.000010	0.0010	0.000021
Mercury	0.320	0.0690	NA	0.0380	0.029	0.000046	0.071	0.045	0.0017	0.091	0.0074	0.011	0.0035	0.0081	0.017
Molybdenum	29.0	0.700	ND	ND	**11**	0.018	0.90	**13**	0.088	0.85	NA	0.94	**5.1**	0.0031	0.90
Nickel	230	26.6	0.00221	24.4	**2.2**	0.0032	**1.2**	**11**	0.065	**3.0**	0.047	**1.6**	0.54	0.043	0.26
Selenium	29.0	1.80	0.00100	1.60	**17**	0.027	**9.4**	**13**	0.095	**5.5**	0.39	**3.2**	**1.1**	0.17	1.0
Silver	2.40	NA	ND	0.241	0.034	0.000053	0.11	0.075	0.000074	0.21	0.0086	0.0083	0.0014	0.0056	0.0067
Thallium	1.30	0.428	0.000150	0.378	**4.7**	0.0069	0.12	**29**	0.74	0.32	0.039	**314**	**2.5**	1.0	0.056
Uranium	42.0	3.76	0.00120	2.37	0.12	0.00016	0.075	**1.1**	0.0063	0.22	0.0053	0.45	0.62	0.0037	0.29
Vanadium	370	57.3	0.00620	45.2	0.79	0.0011	**31**	0.68	0.018	**18**	0.40	0.69	0.16	0.13	**2.3**
Zinc	1,200	158	0.0150	151	**1.1**	0.0018	**1.5**	**1.3**	0.028	**1.4**	0.11	0.92	0.11	0.18	0.25
Ecological Hazard Criterion:					1	1	1	1	1	1	1	1	1	1	1

Notes:

[a] The abiotic media exposure point concentrations used in the Tier I Background Ecological Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at background locations.

[b] Ecological dose and HQ estimates for terrestrial and riparian herbivorous and omnivorous species preferentially used the maximum detected COPEC concentration measured in upland and riparian vegetation from background sampling locations, where available, over plant tissue concentrations modeled from abiotic media.

Bold indicates exceedance of IDEQ's and USEPA's acceptable ecological hazard criterion

COPEC - constituent of potential ecological concern
EPC - exposure point concentration
HQ - Hazard quotient
IDEQ - Idaho Department of Environmental Quality

mg/kg - milligrams per kilogram
mg/L - milligrams per liter
NA - not applicable
na - not available

ND - not detected
NOAEL - no observed adverse effects level
USEPA - U. S. Environmental Protection Agency

Table A4-24
Summary of Tier II Henry Site Hazard Estimates for Ecological Receptors

	EPC [a]				Ecological Hazard Estimates (HQ)									
	Upland Soil (mg/kg)	Riparian Soil (mg/kg)	Surface Water (mg/L)	Sediment (mg/kg)	Long-Tailed Vole[b]	American Goldfinch[b]	Deer Mouse[b]	Raccoon[b]	American Robin[b]	Mallard	Mink	Coyote[b]	Great Blue Heron	Northern Harrier
					NOAEL-Based Ecological Hazard Estimates									
Aluminum	NA	NA	0.165	NA	0.012	0.00035	0.013	**1.8**	0.00020	**1.3**	**60**	0.00093	0.0010	0.00012
Antimony	4.81	6.17	0.000657	6.03	**3.3**	na	**7.5**	0.48	na	na	**9.6**	0.36	na	na
Arsenic	24.9	NA	0.00928	7.49	0.65	0.49	0.45	0.0025	0.27	0.042	0.82	0.038	0.11	0.016
Cadmium	32.5	7.38	0.00371	27.1	1.0	0.92	**13**	0.15	**6.8**	0.31	**4.4**	0.29	0.76	0.32
Chromium	271	123	0.00159	217	**1.3**	**3.1**	**3.2**	0.12	**3.7**	0.31	**3.5**	0.43	0.17	0.71
Copper	124	22.0	0.00263	41.5	0.55	**1.3**	**1.1**	0.024	**1.6**	0.33	**1.3**	0.16	0.16	0.46
Molybdenum	16.8	4.64	0.0111	4.29	**24**	**1.6**	**14**	0.19	0.74	0.047	**6.7**	**3.0**	0.021	0.53
Nickel	212	70.4	0.138	199	**1.8**	**1.1**	**10**	0.17	**2.7**	0.072	**7.7**	0.51	0.48	0.24
Selenium	46.4	14.9	0.102	49.8	**38**	**19**	**23**	0.88	**9.3**	**6.1**	**80**	**1.5**	**11**	**1.3**
Thallium	1.31	0.200	0.0000813	1.12	**23**	0.29	**36**	0.58	0.36	0.12	**176**	**2.5**	0.55	0.056
Uranium	40.5	1.43	0.00586	30.6	0.11	0.072	1.0	0.011	0.22	0.069	0.45	0.60	0.0023	0.28
Vanadium	212	165	0.00989	231	0.47	**18**	0.40	0.053	**10**	**2.0**	**2.0**	0.093	0.50	**1.3**
Zinc	890	397	0.484	1,385	0.32	0.60	0.93	0.047	**1.1**	0.23	**11**	0.097	**3.6**	0.24
					LOAEL-Based Ecological Hazard Estimates									
Aluminum	NA	NA	0.165	NA	0.0012	na	0.0013	0.18	na	na	**6.0**	0.000093	na	na
Antimony	4.81	6.17	0.000657	6.03	0.33	na	0.75	0.048	na	na	0.96	0.036	na	na
Arsenic	24.9	NA	0.00928	7.49	0.41	0.31	0.28	0.0016	0.17	0.027	0.51	0.024	0.070	0.010
Cadmium	32.5	7.38	0.00371	27.1	0.85	0.57	**11**	0.13	**4.2**	0.19	**3.7**	0.25	0.47	0.20
Chromium	271	123	0.00159	217	**1.1**	**3.0**	**2.7**	0.10	**3.5**	0.30	**3.0**	0.36	0.16	0.68
Copper	124	22.0	0.00263	41.5	0.46	**1.1**	0.90	0.019	**1.4**	0.29	1.0	0.13	0.14	0.40
Molybdenum	16.8	4.64	0.0111	4.29	**2.4**	0.16	**1.4**	0.019	0.073	0.0047	0.67	0.30	0.0021	0.052
Nickel	212	70.4	0.138	199	**1.1**	0.61	**6.4**	0.10	**1.6**	0.042	**4.8**	0.32	0.28	0.14
Selenium	46.4	14.9	0.102	49.8	**37**	**15**	**23**	0.87	**7.3**	**4.8**	**79**	**1.4**	**8.6**	1.0
Thallium	1.31	0.200	0.0000813	1.12	**2.3**	0.029	**3.6**	0.058	0.036	0.012	**18**	0.25	0.055	0.0056
Uranium	40.5	1.43	0.00586	30.6	0.056	na	0.53	0.0053	na	na	0.22	0.30	na	na
Vanadium	212	165	0.00989	231	0.38	**15**	0.32	0.043	**8.6**	**1.7**	**1.6**	0.076	0.41	**1.1**
Zinc	890	397	0.484	1,385	0.32	0.59	0.92	0.047	**1.1**	0.23	**11**	0.097	**3.6**	0.24
				Ecological Hazard Criterion:	1	1	1	1	1	1	1	1	1	1

Notes:

[a] The abiotic media exposure point concentrations used in the Tier II Ecological Risk Assessment are equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration measured in samples collected from the Henry Site.

[b] Ecological dose and HQ estimates for terrestrial and riparian herbivorous and omnivorous species preferentially used either the maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean detected COPEC concentration measured in upland and riparian vegetation from Henry Site sampling locations, where available, over plant tissue concentrations modeled from abiotic media.

Bold indicates exceedance of IDEQ's and USEPA's acceptable ecological hazard criterion

COPEC - constituent of potential ecological concern
EPC - exposure point concentration
HQ - Hazard quotient
IDEQ - Idaho Department of Environmental Quality
LOAEL - lowest observed adverse effects level
mg/kg - milligrams per kilogram
mg/L - milligrams per liter
NA - not applicable
na - not available
ND - not detected
NOAEL - no observed adverse effects level
USEPA - U. S. Environmental Protection Agency

Table A4-25
Summary of Tier II Background Hazard Estimates for Ecological Receptors

	EPC [a]				Ecological Hazard Estimates (HQ)									
	Upland Soil (mg/kg)	**Riparian Soil (mg/kg)**	**Surface Water (mg/L)**	**Sediment (mg/kg)**	**Long-Tailed Vole[b]**	**American Goldfinch[b]**	**Deer Mouse[b]**	**Raccoon[b]**	**American Robin[b]**	**Mallard**	**Mink**	**Coyote[b]**	**Great Blue Heron**	**Northern Harrier**
					NOAEL-Based Ecological Hazard Estimates									
Aluminum	NA	NA	0.0990	NA	0.0071	0.00021	0.0075	**1.1**	0.00012	0.78	**36**	0.00056	0.00061	0.000069
Antimony	1.04	5.50	NA	5.00	**28**	na	**12**	0.43	na	na	**21**	0.16	na	na
Arsenic	8.20	NA	0.000735	4.55	0.15	0.14	0.14	0.0013	0.091	0.028	0.10	0.013	0.0096	0.0059
Cadmium	13.6	2.81	0.000100	2.29	0.32	0.34	**6.6**	0.068	**3.4**	0.056	0.51	0.15	0.12	0.18
Chromium	108	27.9	0.000775	26.3	0.90	**1.6**	**1.4**	0.028	**1.5**	0.089	0.93	0.20	0.038	0.35
Copper	27.0	18.5	NA	25.5	0.43	0.65	0.36	0.023	0.44	0.29	**1.6**	0.10	0.34	0.34
Molybdenum	7.94	0.508	NA	NA	**2.7**	0.22	**3.4**	0.061	0.23	NA	0.68	**1.4**	0.0023	0.25
Nickel	69.8	20.2	0.00129	19.7	0.78	0.39	**3.4**	0.052	0.91	0.050	**1.3**	0.23	0.032	0.12
Selenium	6.67	1.12	0.000579	1.01	**1.8**	**1.2**	**2.7**	0.079	**1.4**	0.27	**2.4**	0.49	0.11	0.54
Thallium	0.510	0.333	0.000150	0.378	**2.0**	0.049	**11**	0.65	0.13	0.039	**312**	0.97	1.0	0.022
Uranium	10.2	2.91	0.000529	2.37	0.041	0.020	0.27	0.0050	0.055	0.0053	0.35	0.15	0.0029	0.069
Vanadium	93.3	37.0	0.00140	33.0	0.20	**7.8**	0.17	0.012	**4.5**	0.29	0.44	0.041	0.088	0.59
Zinc	473	117	0.00525	107	0.65	0.78	0.90	0.025	0.92	0.10	0.68	0.086	0.10	0.22
					LOAEL-Based Ecological Hazard Estimates									
Aluminum	NA	NA	0.0990	NA	0.00071	na	0.00075	0.11	na	na	**3.6**	0.000056	na	na
Antimony	1.04	5.50	NA	5.00	**2.8**	na	**1.2**	0.043	na	na	**2.1**	0.016	na	na
Arsenic	8.20	NA	0.000735	4.55	0.094	0.086	0.090	0.00084	0.058	0.018	0.065	0.0081	0.0061	0.0037
Cadmium	13.6	2.81	0.000100	2.29	0.27	0.21	**5.6**	0.058	**2.1**	0.034	0.43	0.13	0.073	0.11
Chromium	108	27.9	0.000775	26.3	0.77	**1.5**	**1.2**	0.024	**1.5**	0.085	0.79	0.17	0.037	0.33
Copper	27.0	18.5	NA	25.5	0.35	0.56	0.30	0.019	0.38	0.25	**1.3**	0.086	0.29	0.29
Molybdenum	7.94	0.508	NA	NA	0.27	0.022	0.34	0.0061	0.023	NA	0.068	0.14	0.00022	0.025
Nickel	69.8	20.2	0.00129	19.7	0.49	0.23	**2.2**	0.032	0.53	0.029	0.81	0.15	0.019	0.070
Selenium	6.67	1.12	0.000579	1.01	**1.8**	0.97	**2.7**	0.078	**1.1**	0.22	**2.4**	0.48	0.084	0.43
Thallium	0.510	0.333	0.000150	0.378	0.20	0.0049	**1.1**	0.065	0.013	0.0039	**31**	0.097	0.10	0.0022
Uranium	10.2	2.91	0.000529	2.37	0.020	na	0.13	0.0025	na	na	0.18	0.075	na	na
Vanadium	93.3	37.0	0.00140	33.0	0.16	**6.5**	0.14	0.0095	**3.8**	0.24	0.36	0.033	0.073	0.49
Zinc	473	117	0.00525	107	0.64	0.78	0.90	0.024	0.92	0.10	0.68	0.086	0.099	0.22
Ecological Hazard Criterion:					1	1	1	1	1	1	1	1	1	1

Notes:

[a] The abiotic media exposure point concentrations used in the Tier II Background Ecological Risk Assessment are equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the lower of the maximum detected concentration measured in samples collected from Background locations.

[b] Ecological dose and HQ estimates for terrestrial and riparian herbivorous and omnivorous species preferentially used either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean detected COPEC concentration or the maximum detected concentration measured in upland and riparian vegetation from background sampling locations, where available, over plant tissue concentrations modeled from abiotic media.

Bold indicates exceedance of IDEQ's and USEPA's acceptable ecological hazard criterion

COPEC - constituent of potential ecological concern
EPC - exposure point concentration
HQ - Hazard quotient
IDEQ - Idaho Department of Environmental Quality
LOAEL - lowest observed adverse effects level
mg/kg - milligrams per kilogram
mg/L - milligrams per liter
NA - not applicable
na - not available
ND - not detected
NOAEL - no observed adverse effects level
USEPA - U. S. Environmental Protection Agency

TABLES

SECTION 5

Table A5-1
Summary of Livestock Chemicals of Potential Concern
Henry Site

Analyte	Upland Soil	Surface Water [a]
Aluminum		X
Antimony	X	
Arsenic	X	
Barium		X
Beryllium		
Boron	X	X
Cadmium	X	X
Calcium		
Chromium	X	
Cobalt		X
Copper	X	
Iron		
Lead		
Magnesium		
Manganese	X [b]	X
Mercury	X	
Molybdenum	X	
Nickel	X	X
Potassium		
Selenium	X	X
Silver	X	
Sodium		
Thallium	X	
Uranium	X	X
Vanadium	X	X
Zinc	X	X

Notes:

[a] Dissolved fraction for all analytes except for selenium, which is expressed as total selenium.

[b] Livestock hazard was not evaluated for this chemical in soil because this chemical was not identifed as a mammalian chemical of potential ecological concern. Livestock hazards associated with surface water exposures to this chemical were estimated.

X - livestock chemical of potential concern

Table A5-3
Summary of Tier I Henry Site Hazard Estimates for Livestock

	EPC [a]		Livestock Hazard Estimates (HQ)
	Upland Soil (mg/kg)	**Surface Water (mg/L)**	**Beef Cattle[b]**
			NOAEL-Based Livestock Hazard Estimates
Aluminum	NA	0.905	0.0082
Antimony	9.15	0.00230	0.090
Arsenic	45.5	0.0224	0.081
Barium	NA	0.0810	0.000027
Boron	39.0	0.121	0.013
Cadmium	59.5	0.0352	0.067
Chromium	519	0.00760	0.090
Cobalt	NA	0.0141	0.000034
Copper	172	0.00379	0.026
Manganese	NA	20.4	0.0069
Mercury	0.503	ND	0.00059
Molybdenum	35.7	0.0400	**3.7**
Nickel	425	1.26	0.13
Selenium	318	0.970	**8.2**
Silver	7.30	ND	0.00039
Thallium	2.31	0.000348	**1.6**
Uranium	74.4	0.0206	0.0069
Vanadium	584	0.0885	0.046
Zinc	1,610	4.73	0.028
		Hazard Criterion:	1

Notes:

[a] The abiotic media exposure point concentrations used in the Tier I Henry Site Livestock Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at Henry Site locations.

[b] Dose and HQ estimates for beef cattle preferentially used the maximum detected LCOPC concentration measured in upland vegetation from background sampling locations, where available, over plant tissue concentrations modeled from abiotic media.

Bold indicates exceedance of IDEQ's and USEPA's acceptable hazard criterion

NA - not applicable
ND - not detected
EPC - exposure point concentration
HQ - Hazard quotient
IDEQ - Idaho Department of Environmental Quality
LCOPC - livestock chemical of potential concern
mg/kg - milligrams per kilogram
mg/L - milligrams per liter
NOAEL - no observed adverse effects level
USEPA - U. S. Environmental Protection Agency

Table A5-4
Summary of Tier I Background Hazard Estimates for Livestock

	EPC [a]		Livestock Hazard Estimates (HQ)
	Upland Soil (mg/kg)	Surface Water (mg/L)	Beef Cattle[b]
			NOAEL-Based Livestock Hazard Estimates
Aluminum	NA	0.410	0.0037
Antimony	3.60	NA	0.70
Arsenic	19.0	0.00110	0.0080
Barium	NA	0.0850	0.000029
Boron	25.0	0.0200	0.019
Cadmium	44.0	0.000100	0.028
Chromium	420	0.00393	0.081
Copper	82.0	ND	0.017
Manganese	NA	0.0484	0.000016
Mercury	0.320	NA	0.00071
Molybdenum	29.0	ND	0.28
Nickel	230	0.00221	0.049
Selenium	29.0	0.00100	0.42
Silver	2.40	ND	0.00081
Thallium	1.30	0.000150	0.11
Uranium	42.0	0.00120	0.0025
Vanadium	370	0.00620	0.017
Zinc	1,200	0.0150	0.027
		Hazard Criterion:	1

Notes:

[a] The abiotic media exposure point concentrations used in the Tier I Background Livestock Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at background locations.

[b] Dose and HQ estimates for beef cattle preferentially used the maximum detected LCOPC concentration measured in upland vegetation from background sampling locations, where available, over plant tissue concentrations modeled from abiotic media.

Bold indicates exceedance of IDEQ's and USEPA's acceptable hazard criterion

NA - not applicable
ND - not detected
EPC - exposure point concentration
HQ - Hazard quotient
IDEQ - Idaho Department of Environmental Quality
LCOPC - livestock chemical of potential concern
mg/kg - milligrams per kilogram
mg/L - milligrams per liter
NOAEL - no observed adverse effects level
USEPA - U. S. Environmental Protection Agency

Table A5-5
Summary of Tier II Henry Site Hazard Estimates for Livestock

	EPC [a]		Livestock Hazard Estimates (HQ)
	Upland Soil (mg/kg)	**Surface Water (mg/L)**	**Beef Cattle[b]**
			NOAEL-Based Livestock Hazard Estimates
Molybdenum	16.8	0.0111	0.59
Selenium	46.4	0.102	0.93
Thallium	1.31	0.0000813	0.54
			LOAEL-Based Livestock Hazard Estimates
Molybdenum	16.8	0.0111	0.059
Selenium	46.4	0.102	0.92
Thallium	1.31	0.0000813	0.054
		Hazard Criterion:	1

Notes:

[a] The abiotic media exposure point concentrations used in the Tier II Henry Site Livestock Risk Assessment are equal to the lower of the maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration measured in samples collected from the Henry Site.

[b] Dose and HQ estimates for beef cattle preferentially used the detected LCOPC concentration measured in upland vegetation from background sampling locations, where available, over plant tissue concentrations modeled from abiotic media.

Bold indicates exceedance of IDEQ's and USEPA's acceptable hazard criterion

NA - not applicable
ND - not detected
EPC - exposure point concentration
HQ - Hazard quotient
IDEQ - Idaho Department of Environmental Quality
LCOPC - livestock chemical of potential concern
LOAEL - lowest observed adverse effects level
mg/kg - milligrams per kilogram
mg/L - milligrams per liter
NOAEL - no observed adverse effects level
USEPA - U. S. Environmental Protection Agency

Table A5-6
Summary of Tier II Background Hazard Estimates for Livestock

	EPC [a]		Livestock Hazard Estimates (HQ)
	Upland Soil (mg/kg)	Surface Water (mg/L)	Beef Cattle[b]
			NOAEL-Based Livestock Hazard Estimates
Molybdenum	7.94	NA	0.066
Selenium	6.67	0.000579	0.042
Thallium	0.510	0.000150	0.044
			LOAEL-Based Livestock Hazard Estimates
Molybdenum	7.94	NA	0.0066
Selenium	6.67	0.000579	0.042
Thallium	0.510	0.000150	0.0044
		Hazard Criterion:	1

Notes:

[a] The abiotic media exposure point concentrations used in the Tier II Background Livestock Risk Assessment are equal to the lower of the maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration measured in samples collected from Background locations.

[b] Dose and HQ estimates for beef cattle preferentially used the detected LCOPC concentration measured in upland vegetation from background sampling locations, where available, over plant tissue concentrations modeled from abiotic media.

Bold indicates exceedance of IDEQ's and USEPA's acceptable hazard criterion

NA - not applicable
ND - not detected
EPC - exposure point concentration
HQ - Hazard quotient
IDEQ - Idaho Department of Environmental Quality
LCOPC - livestock chemical of potential concern
LOAEL - lowest observed adverse effects level
mg/kg - milligrams per kilogram
mg/L - milligrams per liter
NOAEL - no observed adverse effects level
USEPA - U. S. Environmental Protection Agency

TABLES

SECTION 7

Table A7-1
Summary of Tier I RME Henry Site and Background Cumulative Risk Estimates for Human Receptors

	Current/Future Native American				Hypothetical Future Resident				Current/Future Seasonal Rancher			
	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]
Upland Soil												
Site-Related	**1E-03**	As, Ra-226	**6**	V, U	**1E-03**	As, Ra-226	**6**	V, U	**2E-03**	As, Ra-226	1	--
Background	**5E-04**	As, Ra-226	**3**	V	**5E-04**	As, Ra-226	**3**	V	**9E-04**	As, Ra-226	0.8	--
Riparian Soil												
Site-Related	**9E-06**	As	**4**	V	8E-07	--	0.3	--				
Background	**1E-05**	As	0.7	--	8E-07	--	0.06	--				
Culturally Significant Plant - Upland Soil												
Site-Related	**3E-03**	As, Ra-226	**22**	Cd, Co, Sb, Se, Tl								
Background	**3E-03**	As	**77**	As, Cd, Co, Mn, Ni, Sb, Se, Tl, V								
Culturally Significant Plant - Riparian Soil												
Site-Related	**4E-04**	As	**57**	As, Cd, Co, Mn, Ni, Sb, Se, Tl, V								
Background	**4E-04**	As	**19**	As, Cd, Co, Mn, Sb, Tl								
Aquatic Plant - Surface Water and Sediment												
Site-Related	**2E-03**	As, Ra-226	**82**	As, Cd, Mn, Ni, Sb, Se, Tl, U, V, Zn								
Background	**2E-04**	As, Ra-226	**6**	Cd								
Fruits and Vegetables - Upland Soil and Groundwater												
Site-Related					**1E-02**	As, Ra-226	**319**	As, Cd, Co, Mn, Mo, Ni, Sb, Se, Tl, U, V				
Background					**3E-03**	As, Ra-226	**70**	As, Cd, Co, Mn, Mo, Ni, Sb, Se, Tl, V				
Surface Water												
Site-Related	**4E-06**	As	0.7	--	6E-07	--	0.1	--				
Background	2E-07	--	0.02	--	3E-08	--	0.003	--				
Fish												
Site-Related	**8E-04**	As, Ra-226	**229**	As, Cd, Ni, Se, Tl, Zn	**8E-04**	As, Ra-226	**229**	As, Cd, Ni, Se, Tl, Zn				
Background	**4E-05**	As	**83**	Sb, Tl	**4E-05**	As	**83**	Sb, Tl				
Groundwater												
Site-Related					**1E-04**	As	**10**	Co, Mn, Se, Tl	**2E-05**	As	0.1	--
Background					**3E-05**	As	1	--	**5E-06**	As	0.02	--
Cattle - Upland Soil and Surface Water												
Site-Related									**2E-04**	As, Ra-226	**15**	Co, Se, Tl
Background									**8E-05**	As	**8**	Co, Tl

Table A7-1
Summary of Tier I RME Henry Site and Background Cumulative Risk Estimates for Human Receptors

	Current/Future Native American				Hypothetical Future Resident				Current/Future Seasonal Rancher			
	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]
Cattle - Upland Soil and Groundwater												
Site-Related									**9E-05**	As, Ra-226	**15**	Co, Se, Tl
Background									**9E-04**	As	**8**	Co, Tl
Elk - Upland Soil and Surface Water												
Site-Related	7E-07	--	0.04	--								
Background	6E-07	--	0.04	--								
Indoor Air												
Site-Related					**6E-02**	Rn-222	--	--				
Background					**5E-02**	Rn-222	--	--				

Notes:
[a] Media-specific cumulative ILCR and HI for all constituent of potential concern (COPCs).
[b] Analytes with a chemical-specific Incremental Tier I RME ILCR or hazard quotient (HQ) greater than the USEPA's risk management range and/or IDEQ's acceptable risk criteria are listed as media-specific risk drivers.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
NA - not applicable
RME - reasonable maximum exposure
USEPA - United States Environmental Protection Agency

Key:
As - arsenic
Cd - cadmium
Co - cobalt
Mo - molybdenum
Mn - manganese
Ni - nickel
Ra - radium
Rn - radon
Sb - antimony
Se - selenium
Tl - thallium
U - uranium
V- vanadium
Zn - zinc

Table A7-2
Summary of Tier II RME Henry Site Cumulative Incremental Risk Estimates for Human Receptors

	Current/Future Native American				Hypothetical Future Resident				Current/Future Seasonal Rancher				Current/Future Recreational Hunter				Current/Future Recreational Camper/Hiker				Current/Future Recreational Fishers			
	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]
Upland Soil																								
Site-Related	**2E-04**	As, Ra-226	2	--	**2E-04**	As, Ra-226	2	--	**4E-04**	As, Ra-226	0.4	--	**1E-04**	Ra-226	0.04	--	**6E-05**	Ra-226	0.04	--				
Background	**9E-05**	As, Ra-226	0.6	--	**9E-05**	As, Ra-226	0.6	--	**2E-04**	As, Ra-226	0.1	--	**4E-05**	Ra-226	0.01	--	**2E-05**	Ra-226	0.01	--				
Incremental	**2E-04**	As, Ra-226	1.1	--	**2E-04**	As, Ra-226	1.1	--	**3E-04**	As, Ra-226	0.2	--	**6E-05**	Ra-226	0.02	--	**4E-05**	Ra-226	0.03	--				
Riparian Soil																								
Site-Related	**8E-06**	As	0.6	--	NA	--	NA	--													NA	--	NA	--
Background	**8E-06**	As	0.2	--	NA	--	NA	--													NA	--	NA	--
Incremental	0E+00	--	0.4	--	NA	--	NA	--													NA	--	NA	--
Culturally Significant Plant - Upland Soil																								
Site-Related	**7E-04**	As, Ra-226	**18**	Cd, Co, Sb, Se, Tl																				
Background	**8E-04**	As, Ra-226	**56**	As, Cd, Co, Sb, Tl																				
Incremental	**3E-04**	Ra-226	**2**	Se																				
Culturally Significant Plant - Riparian Soil																								
Site-Related	**3E-04**	As	**21**	As, Cd, Co, Mn, Sb, Se, Tl, V																				
Background	**3E-04**	As	**15**	As, Co, Mn, Sb, Tl																				
Incremental	0E+00	--	**7**	Se, V																				
Aquatic Plant - Surface Water and Sediment																								
Site-Related	**8E-04**	As, Ra-226	**30**	As, Cd, Mn, Se, U, Zn																				
Background	**2E-04**	As, Ra-226	**5**	Cd																				
Incremental	**5E-04**	As, Ra-226	**24**	Cd, Se, U, Zn																				
Fruits and Vegetables - Upland Soil and Groundwater																								
Site-Related					**2E-03**	As, Ra-226	**78**	As, Cd, Co, Mo, Sb, Se, Tl																
Background					**8E-04**	As, Ra-226	**42**	As, Co, Mo, Sb, Tl																
Incremental					**2E-03**	As, Ra-226	**64**	As, Cd, Mo, Se, Tl																
Surface Water																								
Site-Related	**2E-06**	As	0.009	--	NA	--	NA	--	NA	--	NA	--									NA	--	NA	--
Background	1E-07	--	0.0007	--	NA	--	NA	--	NA	--	NA	--									NA	--	NA	--
Incremental	**2E-06**	As	0.008	--	NA	--	NA	--	NA	--	NA	--									NA	--	NA	--
Fish - Surface Water																								
Site-Related	**3E-04**	As, Ra-226	**48**	As, Cd, Se, Tl, Zn	**3E-04**	As, Ra-226	**48**	As, Cd, Se, Tl, Zn													**3E-04**	As, Ra-226	**48**	As, Cd, Se, Tl, Zn
Background	**3E-05**	As	**76**	Tl	**3E-05**	As	**76**	Tl													**3E-05**	As	**76**	Tl
Incremental	**3E-04**	As, Ra-226	**7**	As, Cd, Se, Zn	**3E-04**	As, Ra-226	**7**	As, Cd, Se, Zn													**3E-04**	As, Ra-226	**7**	As, Cd, Se, Zn
Groundwater																								
Site-Related					**6E-05**	As	**4**	Co, Tl	**1E-05**	As	0.05	--												
Background					**2E-05**	As	1	--	**4E-06**	As	0.01	--												
Incremental					**4E-05**	As	**3**	Co, Tl	**8E-06**	As	0.04	--												

Table A7-2
Summary of Tier II RME Henry Site Cumulative Incremental Risk Estimates for Human Receptors

	Current/Future Native American				Hypothetical Future Resident				Current/Future Seasonal Rancher				Current/Future Recreational Hunter				Current/Future Recreational Camper/Hiker				Current/Future Recreational Fishers			
	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]	ILCR [a]	Risk Drivers [b]	HI [a]	Risk Drivers [b]
Cattle - Upland Soil and Surface Water																								
Site-Related									**7E-05**	As, Ra-226	**6**	Tl												
Background									**2E-05**	As, Ra-226	**3**	Tl												
Incremental									**5E-05**	As, Ra-226	**3**	Tl												
Cattle - Upland Soil and Groundwater																								
Site-Related									**5E-05**	As, Ra-226	**7**	Tl												
Background									**2E-05**	As, Ra-226	**3**	Tl												
Incremental									**3E-05**	As, Ra-226	**4**	Tl												
Elk																								
Site-Related													NA	--	NA	--								
Background													NA	--	NA	--								
Incremental													NA	--	NA	--								
Indoor Air																								
Site-Related					**3E-02**	Rn-222	--																	
Background					**2E-02**	Rn-222	--																	
Incremental					**2E-02**	Rn-222	--																	

Notes:

[a] Media-specific cumulative ILCR and HI for all constituents of potential concern (COPCs) following the Tier I risk assessment.

[b] Analytes with a chemical-specific Incremental Tier II RME ILCR or hazard quotient (HQ) greater than the USEPA's risk management range and/or IDEQ's acceptable risk criteria are listed as media-specific risk drivers.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's acceptable risk criteria.

HI - Hazard Index
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
RME - reasonable maximum exposure
USEPA - United States Environmental Protection Agency

Key:

As - arsenic
Cd - cadmium
Co - cobalt
Mn - manganese
Mo - molybdenum
Ra - radium
Rn - radon
Sb - antimony
Se - selenium
Tl - thallium
V- vanadium
Zn - zinc

Table A7-3
Ecological Risk Drivers for the Tier I Evaluation at the Henry Site and Background Locations

	Long-Tailed Vole	Elk	American Goldfinch	Deer Mouse	Raccoon	American Robin	Mallard	Mink	Coyote	Great Blue Heron	Northern Harrier
NOAEL-Based Ecological Hazard Estimates											
Site - Related:											
Hazard Range	< 0.1 - 333	< 0.1 - 0.55	< 0.1 - 164	< 0.1 - 166	< 0.1 - 9.6	< 0.1 - 60	< 0.1 - 16	< 0.1 - 722	< 0.1 - 6.6	< 0.1 - 101	< 0.1 - 3.7
Risk Drivers [a]	As Cd Cr Cu Mo Ni Sb Se Tl V Zn	--	As Cd Cr Cu Mo Ni Se V Zn	As Cd Cr Cu Mo Ni Sb Se Tl U V Zn	Al Se Tl	Cd Cr Cu Mo Ni Se V Zn	Al Se V	Al As Cd Cr Cu Mo Ni Sb Se Tl V Zn	Mo Se Tl U	Cd Ni Se Tl V Zn	Cr Mo Se V
Background:											
Hazard Range	< 0.1 - 29	< 0.1	< 0.1 - 31	< 0.1 - 29	< 0.1 - 4.4	< 0.1 - 180	< 0.1 - 3.2	< 0.1 - 314	< 0.1 - 5.1	< 0.1 - 1.0	< 0.1 - 2.3
Risk Drivers [a]	Cd Cr Mo Ni Sb Se Tl Zn	--	Cd Cr Cu Ni Se V Zn	Cd Cr Mo Ni Sb Se Tl U Zn	Al	Cd Cr Cu Ni Se V Zn	Al	Al Cr Cu Ni Sb Se Tl	Mo Se Tl	---	V

Notes:
[a] Risk drivers are analytes for which an analyte-specific greater than the USEPA's and IDEQ's acceptable criterion of one was calculated.

-- - not applicable
IDEQ - Idaho Department of Environmental Quality
NOAEL - no observed adverse effects level
USEPA - United States Environmental Protection Agency

Al - aluminum
As - arsenic
Cd - cadmium
Cr - chromium
Cu - copper
Mo - molybdenum
Ni - nickel
Sb - antimony
Se - selenium
Tl - thallium
U - uranium
V- vanadium
Zn - zinc

Table A7-4
Ecological Risk Drivers for the Tier II Evaluation at the Henry Site and Background Locations

	Long-Tailed Vole	American Goldfinch	Deer Mouse	Raccoon	American Robin	Mallard	Mink	Coyote	Great Blue Heron	Northern Harrier
NOAEL-Based Ecological Hazard Estimates										
Site - Related:										
Hazard Range	< 0.1 - 38	< 0.1 - 19	< 0.1 - 36	< 0.1 - 1.8	< 0.1 - 10	< 0.1 - 6.1	0.45 - 176	< 0.1 - 3.0	< 0.1 - 11	< 0.1 - 1.3
Risk Drivers [a]	Cr Mo Ni Se Tl	Cr Cu Mo Ni Se V	Cd Cr Cu Mo Ni Se Tl	Al	Cd Cr Cu Ni Se V Zn	Al Se V	Al Cd Cr Cu Mo Ni Se V Zn	Mo Se Tl	Se Zn	Se V
Background:										
Hazard Range	< 0.1 - 28	< 0.1 - 7.8	< 0.1 - 12	< 0.1 - 1.1	< 0.1 - 4.5	< 0.1 - 0.78	< 0.10 - 312	< 0.1 - 1.4	< 0.1 - 1.0	< 0.1 - 0.59
Risk Drivers [a]	Mo Sb Se Tl	Cr Se V	Cd Cr Mo Ni Sb Se Tl	Al	Cd Cr Se V	--	Al Cu Ni Sb Se Tl	Mo	--	--
LOAEL-Based Ecological Hazard Estimates										
Site - Related:										
Hazard Range	< 0.1 - 37	< 0.1 - 15	< 0.1 - 23	< 0.1 - 0.87	< 0.1 - 8.6	< 0.1 - 4.8	0.22 - 79	< 0.1 - 1.4	< 0.1 - 8.6	< 0.1 - 1.1
Risk Drivers [a]	Cr Mo Ni Se Tl	Cr Cu Se V	Cd Cr Mo Ni Se Tl	--	Cd Cr Cu Ni Se V Zn	Se V	Al Cd Cr Ni Se V Zn	Se	Se Zn	V
Background:										
Hazard Range	< 0.1 - 2.8	< 0.1 - 6.5	< 0.1 - 5.6	< 0.1 - 0.11	< 0.1 - 3.8	< 0.1 - 0.25	< 0.1 - 31	< 0.1 - 0.48	< 0.1 - 0.29	< 0.1 - 0.49
Risk Drivers [a]	Sb Se	Cr V	Cd Cr Ni Sb Se Tl	--	Cd Cr Se V	--	Al Cu Sb Se Tl	--	--	--

Notes:
[a] Risk drivers are analytes for which an analyte-specific greater than the USEPA's and IDEQ's acceptable criterion of one was calculated. Ecological hazards for antimony in upland soil and antimony and thallium in riparian soil and sediment were greater at background locations than at Henry Site locations, and therefore antimony and thallium are not risk drivers in the indicated media.

-- - not applicable
IDEQ - Idaho Department of Environmental Quality
NOAEL - no observed adverse effects level
USEPA - United States Environmental Protection Agency

Al - aluminum
Cd - cadmium
Cr - chromium
Cu - copper
Mo - molybdenum
Ni - nickel
Sb - antimony
Se - selenium
Tl - thallium
V- vanadium
Zn - zinc

Table A7-5
Livestock Risk Drivers for the Tier I and Tier II Evaluations at the Henry Site and Background Locations

	Tier I NOAEL-Based	Tier II-NOAEL-Based	Tier II LOAEL-Based
Site - Related:			
Hazard Range	< 0.001 - 8.2	0.54 - 0.93	0.054 - 0.92
Risk Drivers [a]	Mo, Se, Tl	--	--
Background:			
Hazard Range	< 0.001 - 0.70	0.042 - 0.066	0.0044 - 0.042
Risk Drivers [a]	--	--	--

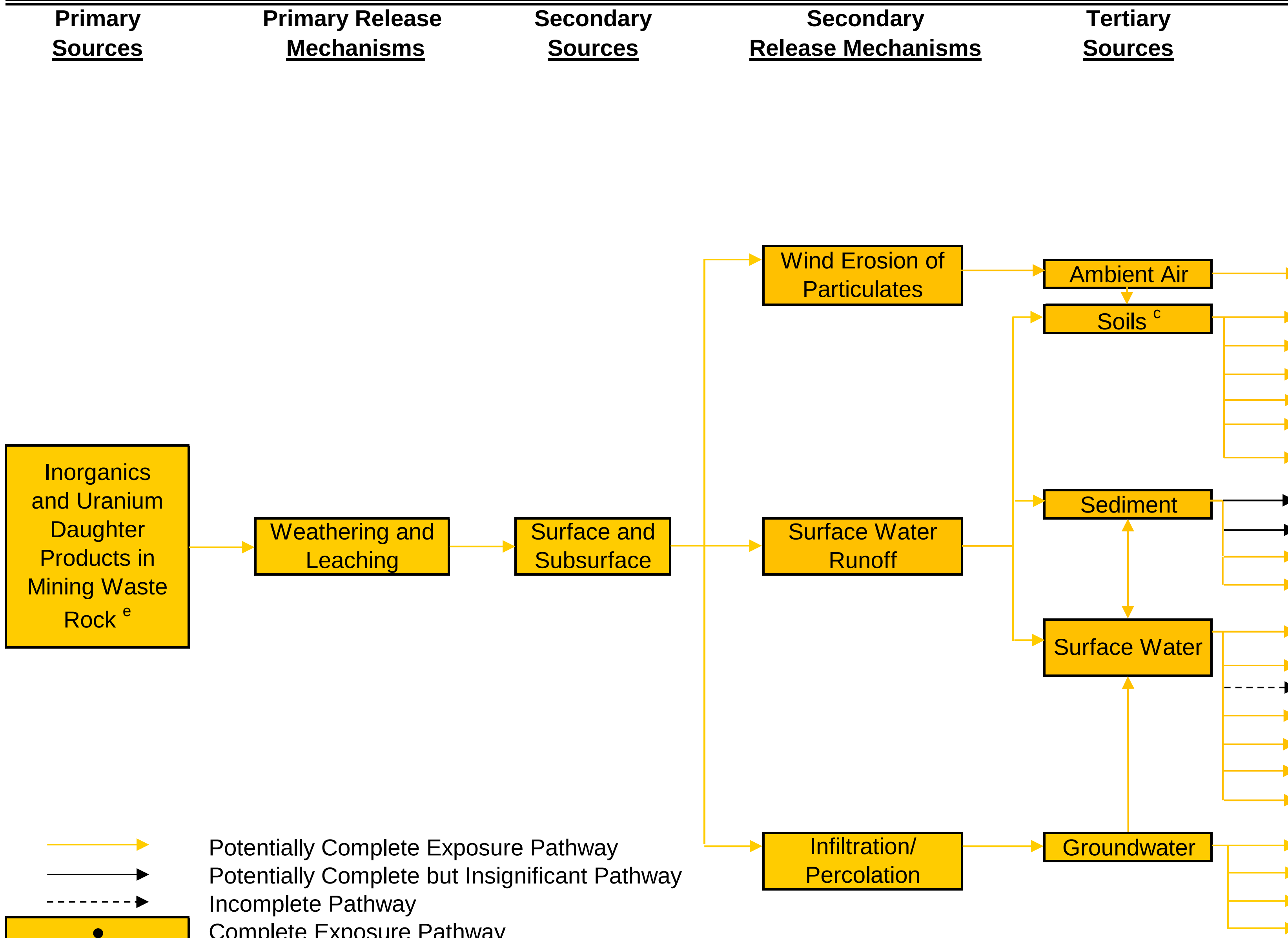
Notes:
[a] Risk drivers are analytes for which an analyte-specific greater than the USEPA's and IDEQ's acceptable criterion of one was calculated.

-- - not applicable
IDEQ - Idaho Department of Environmental Quality
LOAEL - lowest observed adverse effects level
NOAEL - no observed adverse effects level
USEPA - United States Environmental Protection Agency

mo - molybdenum
se - selenium
Tl - thallium

FIGURES

FIGURE A3-1
HUMAN HEALTH CONCEPTUAL SITE MODEL
HENRY SITE



Tertiary Sources	Exposure Routes	Native American	Hypothetical Future Resident	Seasonal Rancher	Recreational Hunter	Recreational Camper/Hiker	Recreational Fisher
Ambient Air	Fugitive Dust Inhalation	●	●	●	●	●	●
Soils [c]	Incidental Ingestion	●	●	●	●	●	●
	Dermal Contact	●	●	●	●	●	●
	External Exposure [e]	●	●	●	●	●	●
	Uptake by Plants	●	●	○	○	○	○
	Uptake by Moose, Elk, and other Wild Game	●	●	○	●	●	●
	Uptake by Beef Cattle and Livestock	○	●	●	○	○	○
Sediment	Incidental Ingestion	●	●	○	○	●	●
	Dermal Contact	●	●	○	○	●	●
	Uptake by Plants	●	○	○	○	○	○
	Uptake by Fish	○	○	○	○	●	●
Surface Water	Incidental Ingestion [f]	●	●	●	○	●	●
	Dermal Contact [f]	●	●	○	○	●	●
	Inhalation	○	○	○	○	○	○
	Uptake by Plants	●	○	○	○	○	○
	Uptake by Fish	●	●	○	○	●	●
	Uptake by Moose, Elk, and other Wild Game	●	●	○	●	●	●
	Uptake by Beef Cattle and Livestock	○	●	●	○	○	○
Groundwater	Ingestion	○	●	●	○	○	○
	Washing/Bathing	○	●	●	○	○	○
	Irrigation of Plants	○	●	○	○	○	○
	Water for Livestock	○	●	●	○	○	○

Potential Receptors[a, b]

Legend:
- Potentially Complete Exposure Pathway (yellow arrow)
- Potentially Complete but Insignificant Pathway (black arrow)
- Incomplete Pathway (dashed arrow)
- ● (shaded) Complete Exposure Pathway
- ● Potentially Complete but Insignificant Pathway
- ○ Incomplete Exposure Pathway

Notes:

[a] All potential receptors are both current and future receptors except for hypothetical future residential receptor.

[b] It is possible that some biota consumption pathways could be applicable to multiple receptors. For example, a recreational camper/hiker could hunt. Such alternative exposure pathways are evaluated qualitatively in the Uncertainty Analysis section of the Baseline Risk Assessment.

[c] Exposure to constituents in soil for the current/future recreational hunter, current/future camper/hiker, and current/future seasonal rancher are evaluated quantitatively for upland soil only, as these receptors are not expected to spend a significant amount of time near surface water. The current/future recreational fisher is evaluated for exposure to riparian soil only.

[e] Exposure to uranium daughter products is potentially complete for all potential receptors exposed to Henry Site media via the complete exposure pathways presented. External exposure is only applicable to radiological uranium daughter products and is not applicable to other inorganics. External exposure to radiological uranium daughter products in soil is potentailly complete but insignificant for the recreational fisher because uranium is not a chemical of potential concern in riparian soil.

[f] Direct surface water pathways are incomplete for the current/future recreational hunter, recreational camper/hiker, and seasonal rancher; these receptors are unlikely to spend a significant amount of time near limited surface water, and swimming is an insignificant pathway due to low surface water temperatures.

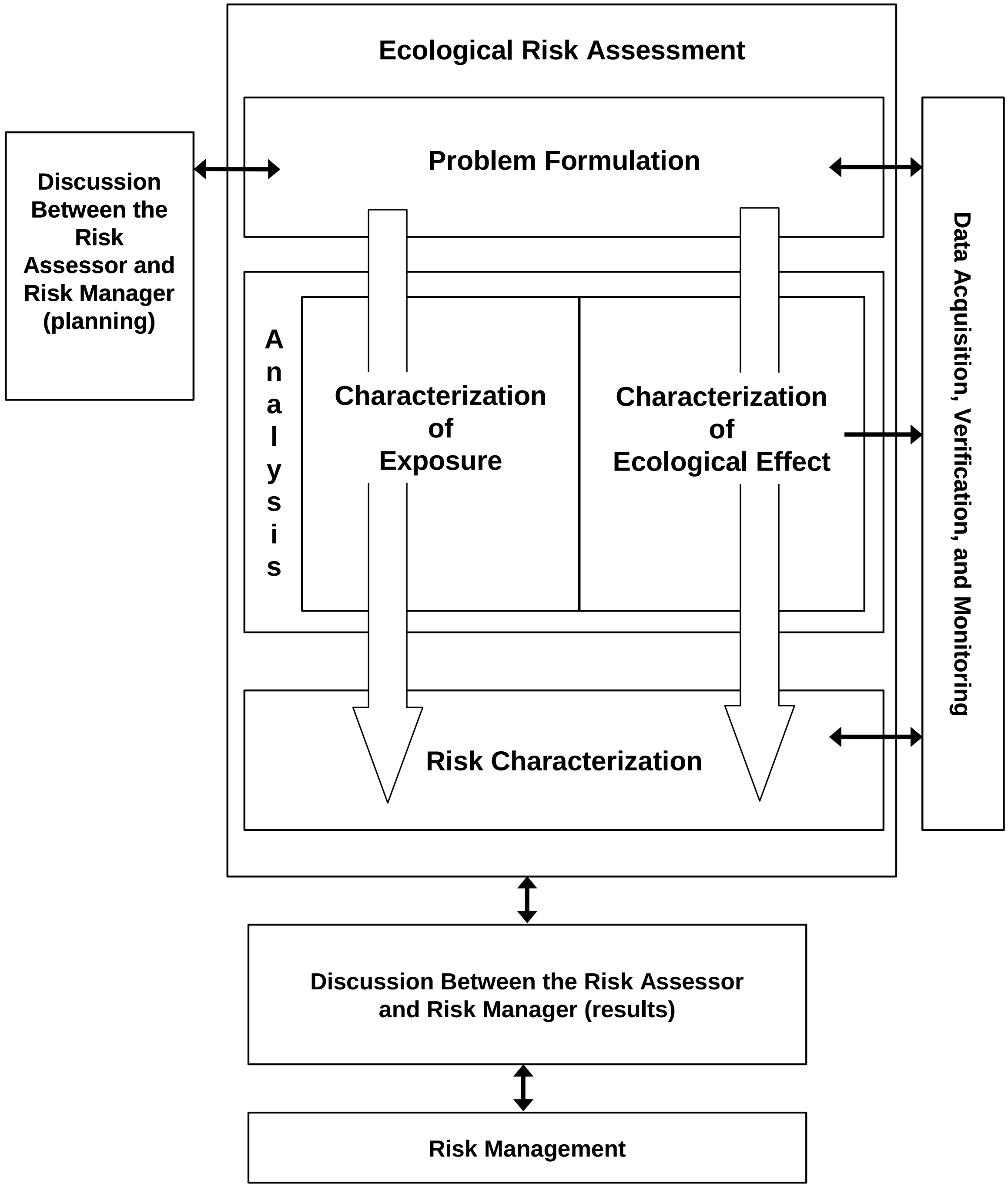
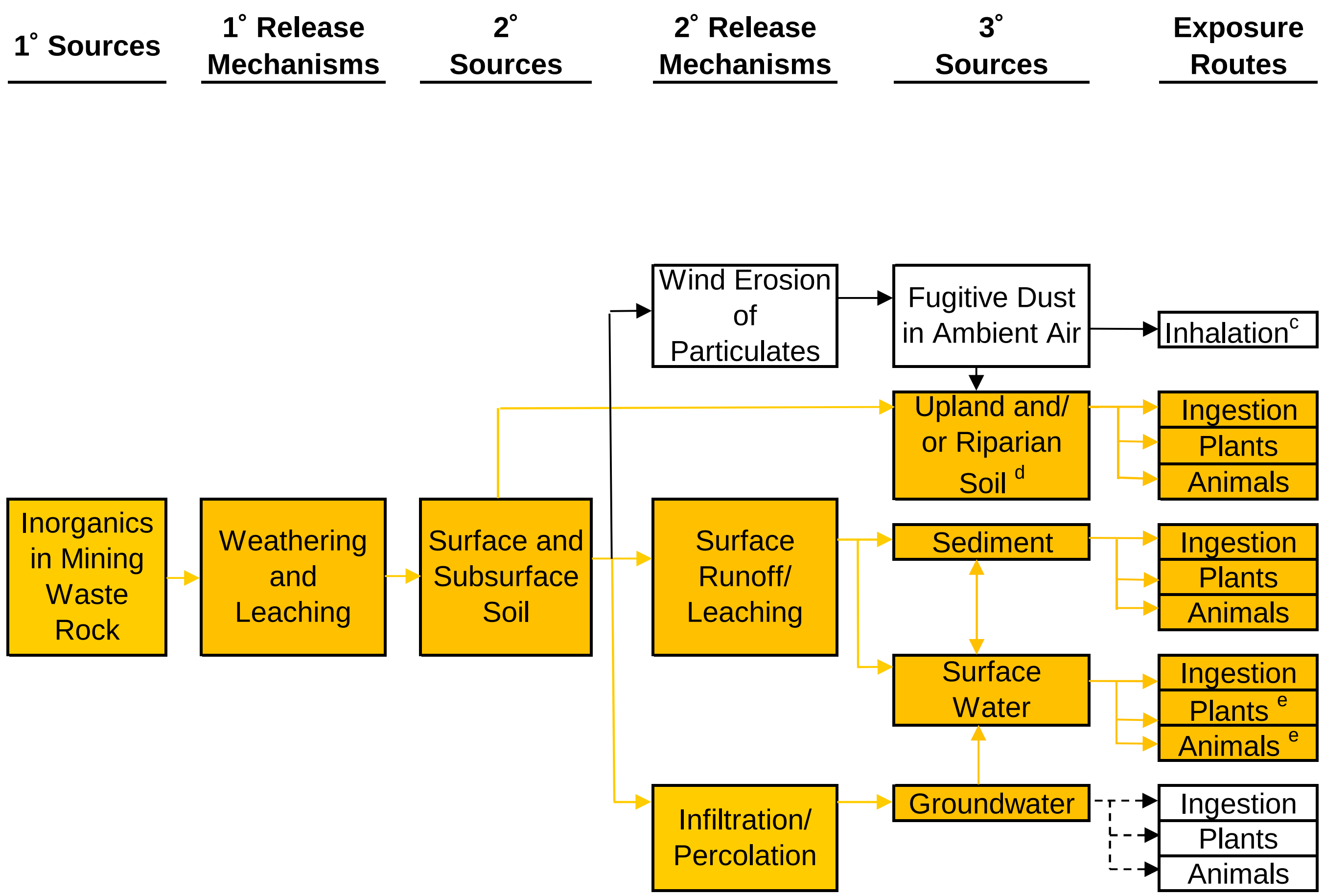


Figure A4-1. Framework for Ecological Risk Assessment (Reproduced from USEPA 1997d Ecological Risk Assessment Guidance for Superfund).

FIGURE A4-2
ECOLOGICAL CONCEPTUAL SITE MODEL
HENRY SITE



Potential Ecological Receptors

3° Source	Exposure Route	Invertebrates: Aquatic	Invertebrates: Terrestrial	Fish [b]	Reptiles [a] and Amphibians	Long-tailed Vole, Elk, and American Goldfinch	Deer Mouse and American Robin	Raccoon	Mallard	Mink	Coyote	Great Blue Heron	Northern Harrier
Fugitive Dust in Ambient Air	Inhalation [c]	○	○	○	●	●	●	●	●	●	●	●	●
Upland and/or Riparian Soil [d]	Ingestion	○	**●**	○	**●**	**●**	**●**	**●**	○	**●**	**●**	●	**●**
	Plants	○	**●**	○	**●**	**●**	**●**	**●**	○	●	**●**	○	○
	Animals	○	○	○	**●**	○	**●**	**●**	○	**●**	**●**	**●**	**●**
Sediment	Ingestion	**●**	○	**●**	**●**	○	○	●	**●**	●	○	**●**	○
	Plants	**●**	○	**●**	**●**	○	○	**●**	**●**	●	○	○	○
	Animals	**●**	○	**●**	**●**	○	○	**●**	**●**	**●**	○	**●**	○
Surface Water	Ingestion	**●**	**●**	**●**	**●**	**●**	**●**	**●**	**●**	**●**	**●**	**●**	**●**
	Plants [e]	**●**	○	**●**	**●**	○	○	**●**	**●**	○	○	○	○
	Animals [e]	**●**	○	**●**	**●**	○	○	**●**	**●**	**●**	○	**●**	○
Groundwater	Ingestion	○	○	○	○	○	○	○	○	○	○	○	○
	Plants	○	○	○	○	○	○	○	○	○	○	○	○
	Animals	○	○	○	○	○	○	○	○	○	○	○	○

Potentially Complete Exposure Pathway
Potentially Complete but Insignificant Pathway
Incomplete Pathway
● Complete Exposure Pathway
● Potentially Complete but Insignificant Pathway
○ Incomplete Exposure Pathway

Notes:

[a] Potential effects to reptiles are evaluated qualitatively.

[b] The surface water bodies at the Henry Site support fish, or have the potential to support fish, as described in the Remedial Investigation and Feasibility Study Work Plan (MWH, 2011).

[c] The inhalation pathway is minor relative to the ingestion pathway and there is a lack of relevant toxicological information; therefore this pathway was not evaluated quantitatively for ecological receptors.

[d] For the purpose of the risk assessment, American goldfinch, American robin, coyote, deer mouse, elk, long-tailed vole, and Northern harrier are exposed to upland soil only; and mink, great blue heron and raccoon are exposed to riparian soil only.

[e] Exposure to chemicals of potential ecological concern in surface water through the ingestion of aquatic plants and/or animal pathways were quantitatively evaluated using sediment data when sediment data were available.

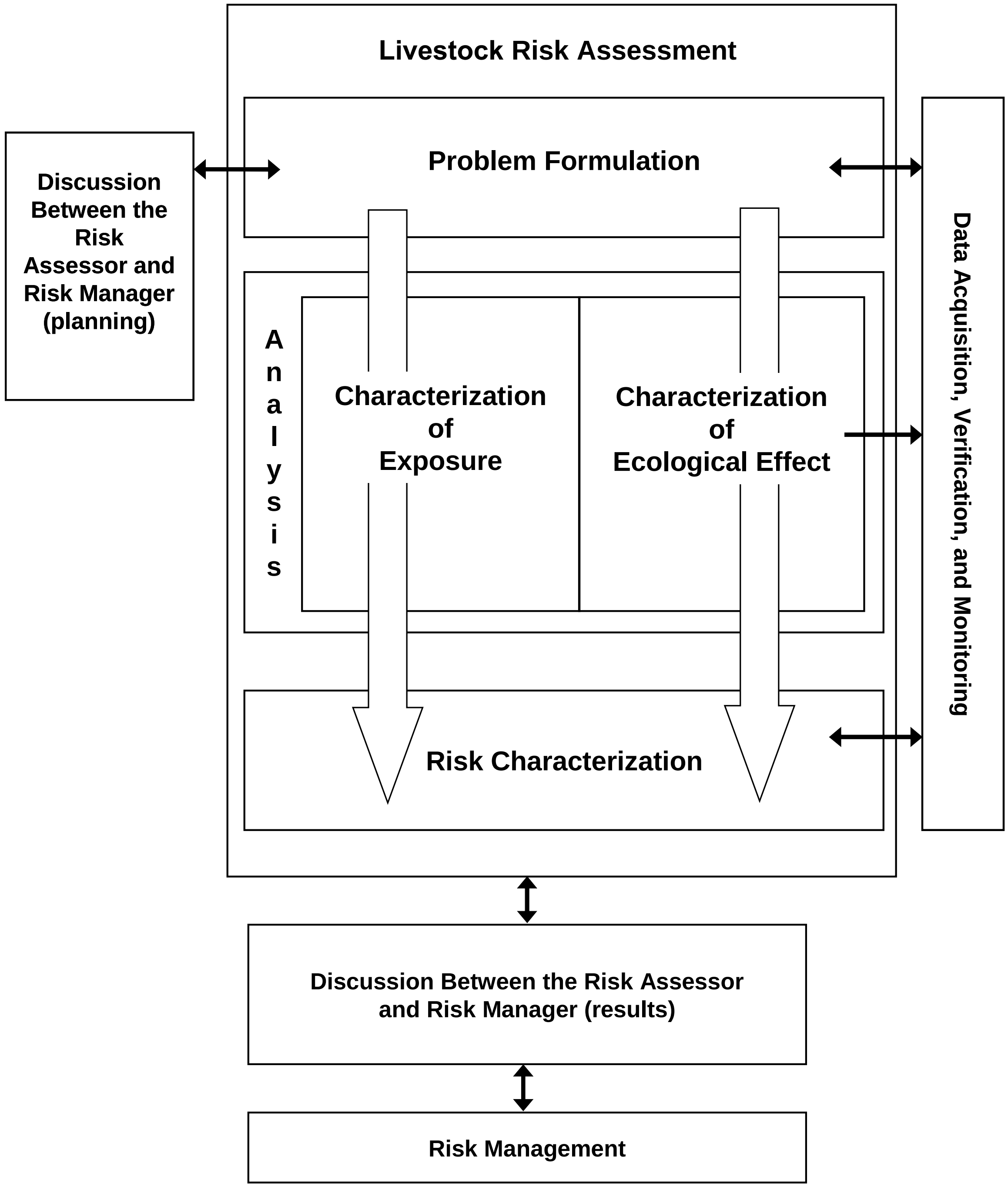
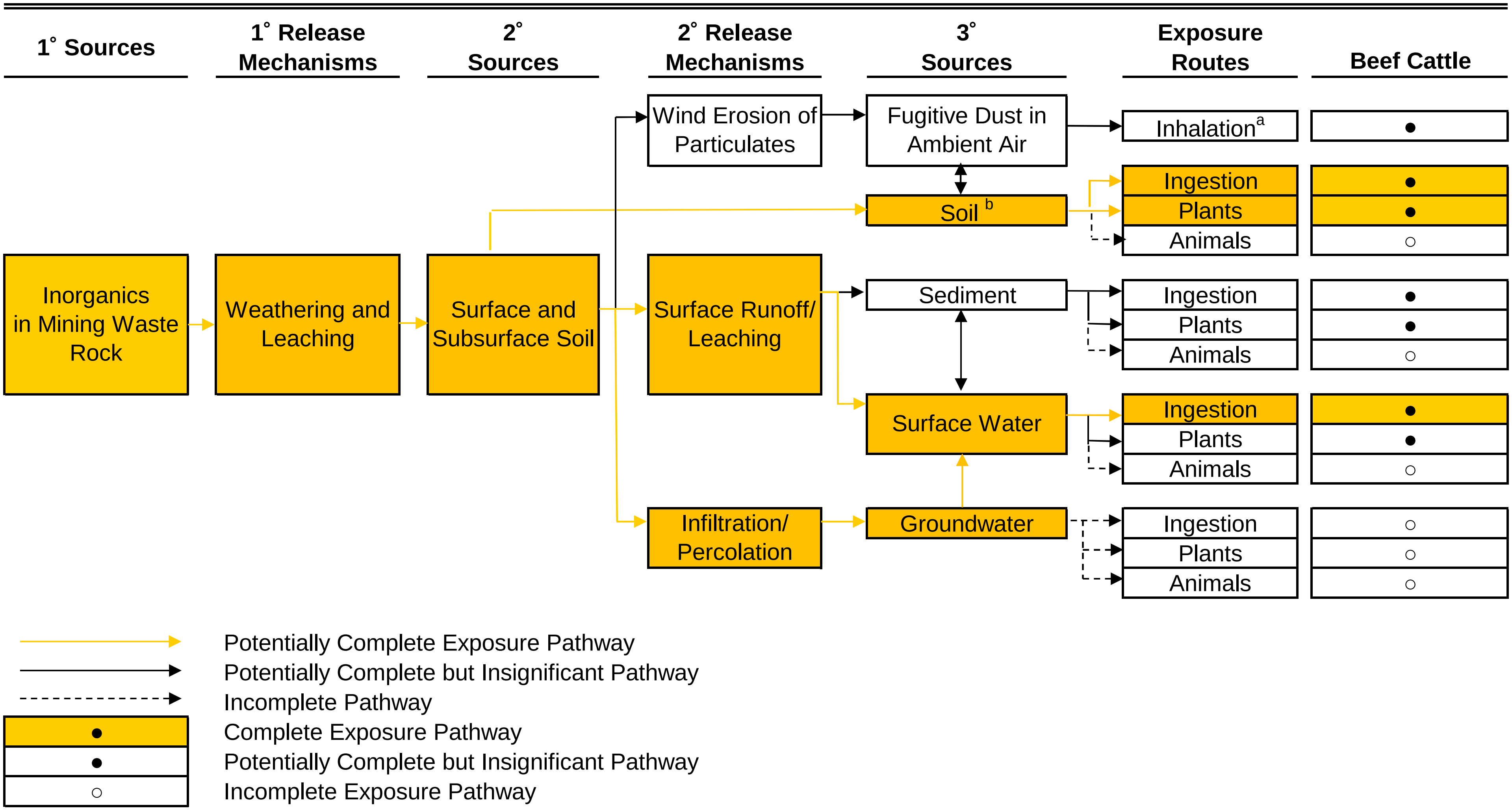


Figure A5-1. Framework for Ecological Risk Assessment (Reproduced from USEPA 1997d Ecological Risk Assessment Guidance for Superfund).

FIGURE A5-2
LIVESTOCK CONCEPTUAL SITE MODEL
HENRY SITE



Notes:

[a] The inhalation pathway is a relatively minor exposure route compared with the ingestion pathway, and data and methods for modeling exposure and effects associated with inhalation are insufficient at this time. Therefore this pathway is not evaluated quantitatively for beef cattle.

[b] For the purpose of the livestock risk assessment, beef cattle are assumed to be exposed to upland soil only.

ATTACHMENTS

ATTACHMENT A – PROUCL OUTPUT

Henry Site Upland Soil

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	4/4/2016 2:44:20 PM
From File	ProUCLinput-UPSO.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Antimony

General Statistics

Total Number of Observations	60	Number of Distinct Observations	57
Number of Detects	55	Number of Non-Detects	5
Number of Distinct Detects	53	Number of Distinct Non-Detects	4
Minimum Detect	0.685	Minimum Non-Detect	0.351
Maximum Detect	9.15	Maximum Non-Detect	0.379
Variance Detects	4.538	Percent Non-Detects	8.333%
Mean Detects	4.656	SD Detects	2.13
Median Detects	4.643	CV Detects	0.458
Skewness Detects	0.048	Kurtosis Detects	-0.609
Mean of Logged Detects	1.397	SD of Logged Detects	0.597

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.969	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0.317	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.0662	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.119	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	4.297	Standard Error of Mean	0.306
SD	2.345	95% KM (BCA) UCL	4.797
95% KM (t) UCL	4.807	95% KM (Percentile Bootstrap) UCL	4.788
95% KM (z) UCL	4.799	95% KM Bootstrap t UCL	4.798
90% KM Chebyshev UCL	5.214	95% KM Chebyshev UCL	5.629
97.5% KM Chebyshev UCL	6.205	99% KM Chebyshev UCL	7.337

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.968	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.755	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.143	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.121	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.705	k star (bias corrected MLE)	3.515
Theta hat (MLE)	1.257	Theta star (bias corrected MLE)	1.325

nu hat (MLE)	407.5	nu star (bias corrected)	386.6
MLE Mean (bias corrected)	4.656	MLE Sd (bias corrected)	2.483

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	3.357	nu hat (KM)	402.8
Approximate Chi Square Value (402.84, α)	357.3	Adjusted Chi Square Value (402.84, β)	356.3
95% Gamma Approximate KM-UCL (use when n>=50)	4.844	95% Gamma Adjusted KM-UCL (use when n<50)	4.859

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.685	Mean	4.374
Maximum	9.15	Median	4.57
SD	2.245	CV	0.513
k hat (MLE)	3.017	k star (bias corrected MLE)	2.877
Theta hat (MLE)	1.45	Theta star (bias corrected MLE)	1.52
nu hat (MLE)	362	nu star (bias corrected)	345.3
MLE Mean (bias corrected)	4.374	MLE Sd (bias corrected)	2.579
		Adjusted Level of Significance (β)	0.046
Approximate Chi Square Value (345.25, α)	303.2	Adjusted Chi Square Value (345.25, β)	302.2
95% Gamma Approximate UCL (use when n>=50)	4.981	95% Gamma Adjusted UCL (use when n<50)	4.997

Lognormal GOF Test on Detected Observations Only

Lilliefors Test Statistic	0.177	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.119	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	4.364	Mean in Log Scale	1.292
SD in Original Scale	2.26	SD in Log Scale	0.67
95% t UCL (assumes normality of ROS data)	4.851	95% Percentile Bootstrap UCL	4.825
95% BCA Bootstrap UCL	4.851	95% Bootstrap t UCL	4.838
95% H-UCL (Log ROS)	5.437		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	4.283	Mean in Log Scale	1.138
SD in Original Scale	2.389	SD in Log Scale	1.037
95% t UCL (Assumes normality)	4.798	95% H-Stat UCL	7.399

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	4.807	95% KM (Percentile Bootstrap) UCL	4.788

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic

General Statistics

Total Number of Observations	60	Number of Distinct Observations	56
		Number of Missing Observations	0
Minimum	4	Mean	22.62
Maximum	45.5	Median	24.15
SD	10.54	Std. Error of Mean	1.361
Coefficient of Variation	0.466	Skewness	-0.0773

Normal GOF Test

Shapiro Wilk Test Statistic	0.956	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.0628	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.0858	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.114	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	24.89	95% Adjusted-CLT UCL (Chen-1995)	24.84
		95% Modified-t UCL (Johnson-1978)	24.89

Gamma GOF Test

A-D Test Statistic	1.657	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.756	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.162	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.115	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.455	k star (bias corrected MLE)	3.294
Theta hat (MLE)	6.546	Theta star (bias corrected MLE)	6.867
nu hat (MLE)	414.6	nu star (bias corrected)	395.2
MLE Mean (bias corrected)	22.62	MLE Sd (bias corrected)	12.46
		Approximate Chi Square Value (0.05)	350.1
Adjusted Level of Significance	0.046	Adjusted Chi Square Value	349.1

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	25.53	95% Adjusted Gamma UCL (use when n<50)	25.6

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.876	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	1.5670E-6	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.19	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.114	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.386	Mean of logged Data	2.967
Maximum of Logged Data	3.818	SD of logged Data	0.619

Assuming Lognormal Distribution

95% H-UCL	27.6	90% Chebyshev (MVUE) UCL	29.51
95% Chebyshev (MVUE) UCL	32.26	97.5% Chebyshev (MVUE) UCL	36.07
99% Chebyshev (MVUE) UCL	43.55		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	24.85	95% Jackknife UCL	24.89
95% Standard Bootstrap UCL	24.85	95% Bootstrap-t UCL	24.98
95% Hall's Bootstrap UCL	24.88	95% Percentile Bootstrap UCL	24.74
95% BCA Bootstrap UCL	24.81		
90% Chebyshev(Mean, Sd) UCL	26.7	95% Chebyshev(Mean, Sd) UCL	28.55
97.5% Chebyshev(Mean, Sd) UCL	31.12	99% Chebyshev(Mean, Sd) UCL	36.16

Suggested UCL to Use

95% Student's-t UCL	24.89

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Boron

General Statistics

Total Number of Observations	60	Number of Distinct Observations	54
Number of Detects	48	Number of Non-Detects	12
Number of Distinct Detects	44	Number of Distinct Non-Detects	10
Minimum Detect	1.99	Minimum Non-Detect	1.88
Maximum Detect	39	Maximum Non-Detect	9.54
Variance Detects	68.77	Percent Non-Detects	20%
Mean Detects	15.97	SD Detects	8.293

Median Detects	16.7	CV Detects	0.519
Skewness Detects	0.297	Kurtosis Detects	0.0277
Mean of Logged Detects	2.577	SD of Logged Detects	0.725

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.962	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.947	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.0956	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.128	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	13.5	Standard Error of Mean	1.175
SD	8.908	95% KM (BCA) UCL	15.45
95% KM (t) UCL	15.46	95% KM (Percentile Bootstrap) UCL	15.36
95% KM (z) UCL	15.43	95% KM Bootstrap t UCL	15.58
90% KM Chebyshev UCL	17.02	95% KM Chebyshev UCL	18.62
97.5% KM Chebyshev UCL	20.84	99% KM Chebyshev UCL	25.19

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.292	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.758	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.141	**Kolmogrov-Smirnoff GOF**	
5% K-S Critical Value	0.129	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.73	k star (bias corrected MLE)	2.574
Theta hat (MLE)	5.85	Theta star (bias corrected MLE)	6.206
nu hat (MLE)	262.1	nu star (bias corrected)	247.1
MLE Mean (bias corrected)	15.97	MLE Sd (bias corrected)	9.957

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	2.295	nu hat (KM)	275.5
Approximate Chi Square Value (275.45, α)	238	Adjusted Chi Square Value (275.45, β)	237.2
95% Gamma Approximate KM-UCL (use when n>=50)	15.62	95% Gamma Adjusted KM-UCL (use when n<50)	15.68

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	1.405	Mean	13.85
Maximum	39	Median	12.5
SD	8.575	CV	0.619
k hat (MLE)	2.207	k star (bias corrected MLE)	2.108
Theta hat (MLE)	6.274	Theta star (bias corrected MLE)	6.57
nu hat (MLE)	264.9	nu star (bias corrected)	252.9

MLE Mean (bias corrected)	13.85	MLE Sd (bias corrected)	9.538
		Adjusted Level of Significance (β)	0.046
Approximate Chi Square Value (252.94, α)	217.1	Adjusted Chi Square Value (252.94, β)	216.3
95% Gamma Approximate UCL (use when n>=50)	16.13	95% Gamma Adjusted UCL (use when n<50)	16.19

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.856	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.947	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.188	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.128	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	13.68	Mean in Log Scale	2.356
SD in Original Scale	8.737	SD in Log Scale	0.795
95% t UCL (assumes normality of ROS data)	15.57	95% Percentile Bootstrap UCL	15.52
95% BCA Bootstrap UCL	15.62	95% Bootstrap t UCL	15.66
95% H-UCL (Log ROS)	18.04		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	13.65	Mean in Log Scale	2.342
SD in Original Scale	8.776	SD in Log Scale	0.826
95% t UCL (Assumes normality)	15.54	95% H-Stat UCL	18.45

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	15.46	95% KM (Percentile Bootstrap) UCL	15.36

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium

General Statistics

Total Number of Observations	60	Number of Distinct Observations	57
		Number of Missing Observations	0
Minimum	2.13	Mean	29.63
Maximum	59.47	Median	31.1
SD	13.52	Std. Error of Mean	1.746
Coefficient of Variation	0.456	Skewness	-0.341

Normal GOF Test

Shapiro Wilk Test Statistic	0.954	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0.0501	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.0857	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.114	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	32.54	95% Adjusted-CLT UCL (Chen-1995)	32.41
		95% Modified-t UCL (Johnson-1978)	32.53

Gamma GOF Test

A-D Test Statistic	3.584	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.76	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.196	**Kolmogrov-Smirnoff Gamma GOF Test**	
5% K-S Critical Value	0.116	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.675	k star (bias corrected MLE)	2.552
Theta hat (MLE)	11.08	Theta star (bias corrected MLE)	11.61
nu hat (MLE)	321	nu star (bias corrected)	306.3
MLE Mean (bias corrected)	29.63	MLE Sd (bias corrected)	18.54
		Approximate Chi Square Value (0.05)	266.7
Adjusted Level of Significance	0.046	Adjusted Chi Square Value	265.8

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	34.02	95% Adjusted Gamma UCL (use when n<50)	34.13

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.75	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	2.532E-13	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.238	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.114	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.756	Mean of logged Data	3.19
Maximum of Logged Data	4.085	SD of logged Data	0.787

Assuming Lognormal Distribution

95% H-UCL	41.17	90% Chebyshev (MVUE) UCL	44.15
95% Chebyshev (MVUE) UCL	49.25	97.5% Chebyshev (MVUE) UCL	56.32
99% Chebyshev (MVUE) UCL	70.22		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	32.5	95% Jackknife UCL	32.54
95% Standard Bootstrap UCL	32.49	95% Bootstrap-t UCL	32.5
95% Hall's Bootstrap UCL	32.45	95% Percentile Bootstrap UCL	32.37
95% BCA Bootstrap UCL	32.44		
90% Chebyshev(Mean, Sd) UCL	34.86	95% Chebyshev(Mean, Sd) UCL	37.23
97.5% Chebyshev(Mean, Sd) UCL	40.53	99% Chebyshev(Mean, Sd) UCL	46.99

Suggested UCL to Use

95% Student's-t UCL 32.54

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Chromium

General Statistics

Total Number of Observations	60	Number of Distinct Observations	57
		Number of Missing Observations	0
Minimum	19.9	Mean	241.6
Maximum	519	Median	243.5
SD	137	Std. Error of Mean	17.69
Coefficient of Variation	0.567	Skewness	0.164

Normal GOF Test

Shapiro Wilk Test Statistic	0.953	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.0479	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.0801	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.114	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	271.1	95% Adjusted-CLT UCL (Chen-1995)	271.1
		95% Modified-t UCL (Johnson-1978)	271.2

Gamma GOF Test

A-D Test Statistic	1.256	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.762	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.111	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.116	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.144	k star (bias corrected MLE)	2.048
Theta hat (MLE)	112.7	Theta star (bias corrected MLE)	118
nu hat (MLE)	257.3	nu star (bias corrected)	245.8
MLE Mean (bias corrected)	241.6	MLE Sd (bias corrected)	168.8
		Approximate Chi Square Value (0.05)	210.5
Adjusted Level of Significance	0.046	Adjusted Chi Square Value	209.7

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	282.1	95% Adjusted Gamma UCL (use when n<50)	283.2

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.858	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	1.4996E-7	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.15	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.114	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.991	Mean of logged Data	5.236
Maximum of Logged Data	6.252	SD of logged Data	0.84

Assuming Lognormal Distribution

95% H-UCL	339.1	90% Chebyshev (MVUE) UCL	363.4
95% Chebyshev (MVUE) UCL	407.8	97.5% Chebyshev (MVUE) UCL	469.4
99% Chebyshev (MVUE) UCL	590.5		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	270.7	95% Jackknife UCL	271.1
95% Standard Bootstrap UCL	270.8	95% Bootstrap-t UCL	271.4
95% Hall's Bootstrap UCL	272.2	95% Percentile Bootstrap UCL	271
95% BCA Bootstrap UCL	270.2		
90% Chebyshev(Mean, Sd) UCL	294.6	95% Chebyshev(Mean, Sd) UCL	318.7
97.5% Chebyshev(Mean, Sd) UCL	352	99% Chebyshev(Mean, Sd) UCL	417.6

Suggested UCL to Use

95% Student's-t UCL	271.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Cobalt

General Statistics

Total Number of Observations	60	Number of Distinct Observations	58
		Number of Missing Observations	0
Minimum	2.98	Mean	7.286
Maximum	11.9	Median	7.18
SD	2.118	Std. Error of Mean	0.273
Coefficient of Variation	0.291	Skewness	0.199

Normal GOF Test

Shapiro Wilk Test Statistic	0.958	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.0857	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.0933	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.114	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	7.743	95% Adjusted-CLT UCL (Chen-1995)	7.743
		95% Modified-t UCL (Johnson-1978)	7.744

Gamma GOF Test

A-D Test Statistic	0.77	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.751	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.103	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.115	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	11.06	k star (bias corrected MLE)	10.52
Theta hat (MLE)	0.659	Theta star (bias corrected MLE)	0.693
nu hat (MLE)	1327	nu star (bias corrected)	1262
MLE Mean (bias corrected)	7.286	MLE Sd (bias corrected)	2.247
		Approximate Chi Square Value (0.05)	1180
Adjusted Level of Significance	0.046	Adjusted Chi Square Value	1179

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	7.788	95% Adjusted Gamma UCL (use when n<50)	7.801

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.929	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0.00203	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.12	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.114	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.092	Mean of logged Data	1.94
Maximum of Logged Data	2.477	SD of logged Data	0.317

Assuming Lognormal Distribution

95% H-UCL	7.849	90% Chebyshev (MVUE) UCL	8.23
95% Chebyshev (MVUE) UCL	8.646	97.5% Chebyshev (MVUE) UCL	9.223
99% Chebyshev (MVUE) UCL	10.36		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	7.735	95% Jackknife UCL	7.743
95% Standard Bootstrap UCL	7.721	95% Bootstrap-t UCL	7.768
95% Hall's Bootstrap UCL	7.758	95% Percentile Bootstrap UCL	7.727
95% BCA Bootstrap UCL	7.722		
90% Chebyshev(Mean, Sd) UCL	8.106	95% Chebyshev(Mean, Sd) UCL	8.477
97.5% Chebyshev(Mean, Sd) UCL	8.993	99% Chebyshev(Mean, Sd) UCL	10.01

Suggested UCL to Use

95% Student's-t UCL	7.743

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Copper

General Statistics

Total Number of Observations	60	Number of Distinct Observations	48
		Number of Missing Observations	0
Minimum	11.1	Mean	98.72
Maximum	172	Median	115
SD	44.53	Std. Error of Mean	5.748
Coefficient of Variation	0.451	Skewness	-0.595

Normal GOF Test

Shapiro Wilk Test Statistic	0.89	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	9.8688E-6	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.166	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.114	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	108.3	95% Adjusted-CLT UCL (Chen-1995)	107.7
		95% Modified-t UCL (Johnson-1978)	108.3

Gamma GOF Test

A-D Test Statistic	3.869	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.757	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.22	**Kolmogrov-Smirnoff Gamma GOF Test**	
5% K-S Critical Value	0.116	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.119	k star (bias corrected MLE)	2.974
Theta hat (MLE)	31.65	Theta star (bias corrected MLE)	33.19
nu hat (MLE)	374.3	nu star (bias corrected)	356.9
MLE Mean (bias corrected)	98.72	MLE Sd (bias corrected)	57.24
		Approximate Chi Square Value (0.05)	314.2
Adjusted Level of Significance	0.046	Adjusted Chi Square Value	313.2

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	112.2	95% Adjusted Gamma UCL (use when n<50)	112.5

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.799	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	9.339E-11	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.232	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.114	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.407	Mean of logged Data	4.424
Maximum of Logged Data	5.147	SD of logged Data	0.679

Assuming Lognormal Distribution

95% H-UCL	125.6	90% Chebyshev (MVUE) UCL	134.6
95% Chebyshev (MVUE) UCL	148.2	97.5% Chebyshev (MVUE) UCL	167.1
99% Chebyshev (MVUE) UCL	204.2		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	108.2	95% Jackknife UCL	108.3
95% Standard Bootstrap UCL	107.7	95% Bootstrap-t UCL	107.6
95% Hall's Bootstrap UCL	107.4	95% Percentile Bootstrap UCL	108.2
95% BCA Bootstrap UCL	107.5		
90% Chebyshev(Mean, Sd) UCL	116	95% Chebyshev(Mean, Sd) UCL	123.8

97.5% Chebyshev(Mean, Sd) UCL	134.6	99% Chebyshev(Mean, Sd) UCL	155.9

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	123.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Manganese

General Statistics

Total Number of Observations	60	Number of Distinct Observations	57
		Number of Missing Observations	0
Minimum	68.8	Mean	433.2
Maximum	2040	Median	294
SD	399.5	Std. Error of Mean	51.58
Coefficient of Variation	0.922	Skewness	2.594

Normal GOF Test

Shapiro Wilk Test Statistic	0.676	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	1.110E-16	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.253	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.114	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	519.4	95% Adjusted-CLT UCL (Chen-1995)	536.5
		95% Modified-t UCL (Johnson-1978)	522.3

Gamma GOF Test

A-D Test Statistic	2.522	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.763	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.167	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.116	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.065	k star (bias corrected MLE)	1.973
Theta hat (MLE)	209.8	Theta star (bias corrected MLE)	219.6
nu hat (MLE)	247.8	nu star (bias corrected)	236.7
MLE Mean (bias corrected)	433.2	MLE Sd (bias corrected)	308.4

		Approximate Chi Square Value (0.05)	202.1
Adjusted Level of Significance	0.046	Adjusted Chi Square Value	201.3

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	507.4	95% Adjusted Gamma UCL (use when n<50)	509.4

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.948	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0.0243	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.116	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.114	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.231	Mean of logged Data	5.81
Maximum of Logged Data	7.621	SD of logged Data	0.674

Assuming Lognormal Distribution

95% H-UCL	499.9	90% Chebyshev (MVUE) UCL	535.4
95% Chebyshev (MVUE) UCL	589.2	97.5% Chebyshev (MVUE) UCL	663.8
99% Chebyshev (MVUE) UCL	810.3		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	518	95% Jackknife UCL	519.4
95% Standard Bootstrap UCL	519.5	95% Bootstrap-t UCL	559.9
95% Hall's Bootstrap UCL	545.6	95% Percentile Bootstrap UCL	521.2
95% BCA Bootstrap UCL	534.4		
90% Chebyshev(Mean, Sd) UCL	587.9	95% Chebyshev(Mean, Sd) UCL	658
97.5% Chebyshev(Mean, Sd) UCL	755.3	99% Chebyshev(Mean, Sd) UCL	946.4

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	658

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Mercury

General Statistics

Total Number of Observations	60	Number of Distinct Observations	55
		Number of Missing Observations	0
Minimum	0.0221	Mean	0.31

Maximum	0.503	Median	0.364
SD	0.152	Std. Error of Mean	0.0196
Coefficient of Variation	0.49	Skewness	-0.661

Normal GOF Test

Shapiro Wilk Test Statistic	0.871	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	8.2096E-7	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.168	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.114	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.343	95% Adjusted-CLT UCL (Chen-1995)	0.341
		95% Modified-t UCL (Johnson-1978)	0.343

Gamma GOF Test

A-D Test Statistic	4.44	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.762	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.217	**Kolmogrov-Smirnoff Gamma GOF Test**	
5% K-S Critical Value	0.116	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.209	k star (bias corrected MLE)	2.11
Theta hat (MLE)	0.14	Theta star (bias corrected MLE)	0.147
nu hat (MLE)	265.1	nu star (bias corrected)	253.2
MLE Mean (bias corrected)	0.31	MLE Sd (bias corrected)	0.214
		Approximate Chi Square Value (0.05)	217.3
Adjusted Level of Significance	0.046	Adjusted Chi Square Value	216.5

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.362	95% Adjusted Gamma UCL (use when n<50)	0.363

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.745	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	1.461E-13	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.223	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.114	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-3.812	Mean of logged Data	-1.413
Maximum of Logged Data	-0.687	SD of logged Data	0.868

Assuming Lognormal Distribution

95% H-UCL	0.455	90% Chebyshev (MVUE) UCL	0.487
95% Chebyshev (MVUE) UCL	0.548	97.5% Chebyshev (MVUE) UCL	0.633

99% Chebyshev (MVUE) UCL	0.8		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	0.343	95% Jackknife UCL	0.343
95% Standard Bootstrap UCL	0.343	95% Bootstrap-t UCL	0.342
95% Hall's Bootstrap UCL	0.341	95% Percentile Bootstrap UCL	0.342
95% BCA Bootstrap UCL	0.341		
90% Chebyshev(Mean, Sd) UCL	0.369	95% Chebyshev(Mean, Sd) UCL	0.396
97.5% Chebyshev(Mean, Sd) UCL	0.433	99% Chebyshev(Mean, Sd) UCL	0.506

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	0.396

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Molybdenum

General Statistics

Total Number of Observations	60	Number of Distinct Observations	57
Number of Detects	56	Number of Non-Detects	4
Number of Distinct Detects	53	Number of Distinct Non-Detects	4
Minimum Detect	1.41	Minimum Non-Detect	1.05
Maximum Detect	35.7	Maximum Non-Detect	1.14
Variance Detects	76.99	Percent Non-Detects	6.667%
Mean Detects	15.83	SD Detects	8.775
Median Detects	16.7	CV Detects	0.554
Skewness Detects	0.156	Kurtosis Detects	-0.991
Mean of Logged Detects	2.551	SD of Logged Detects	0.734

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.944	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0.0193	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.11	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.118	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	14.85	Standard Error of Mean	1.195
SD	9.175	95% KM (BCA) UCL	16.68

95% KM (t) UCL	16.84	95% KM (Percentile Bootstrap) UCL	16.8
95% KM (z) UCL	16.81	95% KM Bootstrap t UCL	16.87
90% KM Chebyshev UCL	18.43	95% KM Chebyshev UCL	20.06
97.5% KM Chebyshev UCL	22.31	99% KM Chebyshev UCL	26.74

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.161	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.76	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.134	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.12	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.525	k star (bias corrected MLE)	2.401
Theta hat (MLE)	6.271	Theta star (bias corrected MLE)	6.593
nu hat (MLE)	282.8	nu star (bias corrected)	269
MLE Mean (bias corrected)	15.83	MLE Sd (bias corrected)	10.22

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	2.619	nu hat (KM)	314.3
Approximate Chi Square Value (314.27, α)	274.2	Adjusted Chi Square Value (314.27, β)	273.3
95% Gamma Approximate KM-UCL (use when n>=50)	17.02	95% Gamma Adjusted KM-UCL (use when n<50)	17.07

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	1.41	Mean	14.99
Maximum	35.7	Median	14.25
SD	9.055	CV	0.604
k hat (MLE)	2.151	k star (bias corrected MLE)	2.055
Theta hat (MLE)	6.966	Theta star (bias corrected MLE)	7.293
nu hat (MLE)	258.1	nu star (bias corrected)	246.6
MLE Mean (bias corrected)	14.99	MLE Sd (bias corrected)	10.45
		Adjusted Level of Significance (β)	0.046
Approximate Chi Square Value (246.56, α)	211.2	Adjusted Chi Square Value (246.56, β)	210.4
95% Gamma Approximate UCL (use when n>=50)	17.49	95% Gamma Adjusted UCL (use when n<50)	17.56

Lognormal GOF Test on Detected Observations Only

Lilliefors Test Statistic	0.153	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.118	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	14.95	Mean in Log Scale	2.445
SD in Original Scale	9.101	SD in Log Scale	0.814
95% t UCL (assumes normality of ROS data)	16.92	95% Percentile Bootstrap UCL	16.9

95% BCA Bootstrap UCL	16.85	95% Bootstrap t UCL	16.91
95% H-UCL (Log ROS)	20.16		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	14.81	Mean in Log Scale	2.341
SD in Original Scale	9.304	SD in Log Scale	1.064
95% t UCL (Assumes normality)	16.82	95% H-Stat UCL	25.73

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	16.84	95% KM (Percentile Bootstrap) UCL	16.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel

General Statistics

Total Number of Observations	60	Number of Distinct Observations	55
		Number of Missing Observations	0
Minimum	22.5	Mean	191.4
Maximum	425	Median	180
SD	94.12	Std. Error of Mean	12.15
Coefficient of Variation	0.492	Skewness	0.03

Normal GOF Test

Shapiro Wilk Test Statistic	0.964	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.17	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.108	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.114	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	211.7	95% Adjusted-CLT UCL (Chen-1995)	211.4
		95% Modified-t UCL (Johnson-1978)	211.7

Gamma GOF Test

A-D Test Statistic	1.419	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.758	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.142	**Kolmogrov-Smirnoff Gamma GOF Test**

5% K-S Critical Value	0.116	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.975	k star (bias corrected MLE)	2.838
Theta hat (MLE)	64.33	Theta star (bias corrected MLE)	67.45
nu hat (MLE)	357	nu star (bias corrected)	340.5
MLE Mean (bias corrected)	191.4	MLE Sd (bias corrected)	113.6
		Approximate Chi Square Value (0.05)	298.8
Adjusted Level of Significance	0.046	Adjusted Chi Square Value	297.8

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	218.2	95% Adjusted Gamma UCL (use when n<50)	218.9

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.861	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	2.1680E-7	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.142	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.114	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.114	Mean of logged Data	5.077
Maximum of Logged Data	6.052	SD of logged Data	0.689

Assuming Lognormal Distribution

95% H-UCL	244	90% Chebyshev (MVUE) UCL	261.5
95% Chebyshev (MVUE) UCL	288.3	97.5% Chebyshev (MVUE) UCL	325.5
99% Chebyshev (MVUE) UCL	398.5		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	211.4	95% Jackknife UCL	211.7
95% Standard Bootstrap UCL	210.7	95% Bootstrap-t UCL	211.6
95% Hall's Bootstrap UCL	211.5	95% Percentile Bootstrap UCL	211.7
95% BCA Bootstrap UCL	210.9		
90% Chebyshev(Mean, Sd) UCL	227.9	95% Chebyshev(Mean, Sd) UCL	244.4
97.5% Chebyshev(Mean, Sd) UCL	267.3	99% Chebyshev(Mean, Sd) UCL	312.3

Suggested UCL to Use

95% Student's-t UCL	211.7

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Selenium

General Statistics

Total Number of Observations	60	Number of Distinct Observations	59
		Number of Missing Observations	0
Minimum	0.687	Mean	37.35
Maximum	318	Median	29.6
SD	45.86	Std. Error of Mean	5.92
Coefficient of Variation	1.228	Skewness	4.269

Normal GOF Test

Shapiro Wilk Test Statistic	0.62	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.212	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.114	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	47.25	95% Adjusted-CLT UCL (Chen-1995)	50.58
		95% Modified-t UCL (Johnson-1978)	47.79

Gamma GOF Test

A-D Test Statistic	0.559	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.777	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0841	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.118	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.124	k star (bias corrected MLE)	1.079
Theta hat (MLE)	33.22	Theta star (bias corrected MLE)	34.61
nu hat (MLE)	134.9	nu star (bias corrected)	129.5
MLE Mean (bias corrected)	37.35	MLE Sd (bias corrected)	35.96
		Approximate Chi Square Value (0.05)	104.2
Adjusted Level of Significance	0.046	Adjusted Chi Square Value	103.7

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	46.42	95% Adjusted Gamma UCL (use when n<50)	46.67

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.956	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0.0634	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.134	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.114	Data Not Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.375	Mean of logged Data	3.114
Maximum of Logged Data	5.762	SD of logged Data	1.114

Assuming Lognormal Distribution

95% H-UCL	60.61	90% Chebyshev (MVUE) UCL	62.88
95% Chebyshev (MVUE) UCL	72.71	97.5% Chebyshev (MVUE) UCL	86.34
99% Chebyshev (MVUE) UCL	113.1		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	47.09	95% Jackknife UCL	47.25
95% Standard Bootstrap UCL	46.79	95% Bootstrap-t UCL	53.57
95% Hall's Bootstrap UCL	92.31	95% Percentile Bootstrap UCL	48.07
95% BCA Bootstrap UCL	52.31		
90% Chebyshev(Mean, Sd) UCL	55.11	95% Chebyshev(Mean, Sd) UCL	63.16
97.5% Chebyshev(Mean, Sd) UCL	74.32	99% Chebyshev(Mean, Sd) UCL	96.26

Suggested UCL to Use

95% Approximate Gamma UCL	46.42

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Silver

General Statistics

Total Number of Observations	60	Number of Distinct Observations	59
Number of Detects	59	Number of Non-Detects	1
Number of Distinct Detects	58	Number of Distinct Non-Detects	1
Minimum Detect	0.224	Minimum Non-Detect	0.249
Maximum Detect	7.3	Maximum Non-Detect	0.249
Variance Detects	3.239	Percent Non-Detects	1.667%
Mean Detects	3.353	SD Detects	1.8
Median Detects	3.41	CV Detects	0.537
Skewness Detects	0.118	Kurtosis Detects	-0.44
Mean of Logged Detects	0.969	SD of Logged Detects	0.845

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.963	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0.148	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.067	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.115	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	3.301	Standard Error of Mean	0.236
SD	1.814	95% KM (BCA) UCL	3.67
95% KM (t) UCL	3.695	95% KM (Percentile Bootstrap) UCL	3.692
95% KM (z) UCL	3.689	95% KM Bootstrap t UCL	3.693
90% KM Chebyshev UCL	4.009	95% KM Chebyshev UCL	4.33
97.5% KM Chebyshev UCL	4.776	99% KM Chebyshev UCL	5.651

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.931	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.762	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.156	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.117	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.227	k star (bias corrected MLE)	2.125
Theta hat (MLE)	1.506	Theta star (bias corrected MLE)	1.578
nu hat (MLE)	262.8	nu star (bias corrected)	250.7
MLE Mean (bias corrected)	3.353	MLE Sd (bias corrected)	2.3

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	3.31	nu hat (KM)	397.2
Approximate Chi Square Value (397.17, α)	352	Adjusted Chi Square Value (397.17, β)	350.9
95% Gamma Approximate KM-UCL (use when n>=50)	3.724	95% Gamma Adjusted KM-UCL (use when n<50)	3.736

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.224	Mean	3.311
Maximum	7.3	Median	3.389
SD	1.813	CV	0.548
k hat (MLE)	2.175	k star (bias corrected MLE)	2.077
Theta hat (MLE)	1.523	Theta star (bias corrected MLE)	1.594
nu hat (MLE)	261	nu star (bias corrected)	249.3
MLE Mean (bias corrected)	3.311	MLE Sd (bias corrected)	2.298
		Adjusted Level of Significance (β)	0.046
Approximate Chi Square Value (249.26, α)	213.7	Adjusted Chi Square Value (249.26, β)	212.9
95% Gamma Approximate UCL (use when n>=50)	3.862	95% Gamma Adjusted UCL (use when n<50)	3.877

Lognormal GOF Test on Detected Observations Only

Lilliefors Test Statistic	0.194	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.115	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	3.304	Mean in Log Scale	0.939
SD in Original Scale	1.824	SD in Log Scale	0.869
95% t UCL (assumes normality of ROS data)	3.698	95% Percentile Bootstrap UCL	3.683
95% BCA Bootstrap UCL	3.69	95% Bootstrap t UCL	3.711
95% H-UCL (Log ROS)	4.786		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	3.299	Mean in Log Scale	0.918
SD in Original Scale	1.832	SD in Log Scale	0.926
95% t UCL (Assumes normality)	3.694	95% H-Stat UCL	5.049

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	3.695	95% KM (Percentile Bootstrap) UCL	3.692

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Thallium

General Statistics

Total Number of Observations	60	Number of Distinct Observations	58
		Number of Missing Observations	0
Minimum	0.171	Mean	1.198
Maximum	2.31	Median	1.18
SD	0.497	Std. Error of Mean	0.0642
Coefficient of Variation	0.415	Skewness	-0.0516

Normal GOF Test

Shapiro Wilk Test Statistic	0.976	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.493	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.0694	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.114	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.305	95% Adjusted-CLT UCL (Chen-1995)	1.303
		95% Modified-t UCL (Johnson-1978)	1.305

Gamma GOF Test

A-D Test Statistic	1.462	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.753	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.141	**Kolmogrov-Smirnoff Gamma GOF Test**	
5% K-S Critical Value	0.115	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.274	k star (bias corrected MLE)	4.071
Theta hat (MLE)	0.28	Theta star (bias corrected MLE)	0.294
nu hat (MLE)	512.9	nu star (bias corrected)	488.6
MLE Mean (bias corrected)	1.198	MLE Sd (bias corrected)	0.594
		Approximate Chi Square Value (0.05)	438.3
Adjusted Level of Significance	0.046	Adjusted Chi Square Value	437.1

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.335	95% Adjusted Gamma UCL (use when n<50)	1.339

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.858	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	1.6028E-7	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.181	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.114	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.766	Mean of logged Data	0.0591
Maximum of Logged Data	0.837	SD of logged Data	0.563

Assuming Lognormal Distribution

95% H-UCL	1.433	90% Chebyshev (MVUE) UCL	1.527
95% Chebyshev (MVUE) UCL	1.658	97.5% Chebyshev (MVUE) UCL	1.839
99% Chebyshev (MVUE) UCL	2.194		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.304	95% Jackknife UCL	1.305
95% Standard Bootstrap UCL	1.303	95% Bootstrap-t UCL	1.299
95% Hall's Bootstrap UCL	1.305	95% Percentile Bootstrap UCL	1.308
95% BCA Bootstrap UCL	1.296		
90% Chebyshev(Mean, Sd) UCL	1.391	95% Chebyshev(Mean, Sd) UCL	1.478
97.5% Chebyshev(Mean, Sd) UCL	1.599	99% Chebyshev(Mean, Sd) UCL	1.837

Suggested UCL to Use

95% Student's-t UCL	1.305

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Uranium

General Statistics

Total Number of Observations	60	Number of Distinct Observations	58
		Number of Missing Observations	0
Minimum	1.64	Mean	32.48
Maximum	74.4	Median	35.2
SD	14.22	Std. Error of Mean	1.836
Coefficient of Variation	0.438	Skewness	-0.266

Normal GOF Test

Shapiro Wilk Test Statistic	0.93	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.00223	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.162	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.114	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	35.55	95% Adjusted-CLT UCL (Chen-1995)	35.43
		95% Modified-t UCL (Johnson-1978)	35.54

Gamma GOF Test

A-D Test Statistic	4.79	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.759	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.243	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.116	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.749	k star (bias corrected MLE)	2.622
Theta hat (MLE)	11.82	Theta star (bias corrected MLE)	12.39
nu hat (MLE)	329.8	nu star (bias corrected)	314.7
MLE Mean (bias corrected)	32.48	MLE Sd (bias corrected)	20.06
		Approximate Chi Square Value (0.05)	274.6
Adjusted Level of Significance	0.046	Adjusted Chi Square Value	273.7

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	37.22	95% Adjusted Gamma UCL (use when n<50)	37.35

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.707	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	2.220E-15	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.259	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.114	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.495	Mean of logged Data	3.288
Maximum of Logged Data	4.309	SD of logged Data	0.798

Assuming Lognormal Distribution

95% H-UCL	45.98	90% Chebyshev (MVUE) UCL	49.3
95% Chebyshev (MVUE) UCL	55.06	97.5% Chebyshev (MVUE) UCL	63.06
99% Chebyshev (MVUE) UCL	78.76		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	35.5	95% Jackknife UCL	35.55
95% Standard Bootstrap UCL	35.48	95% Bootstrap-t UCL	35.4
95% Hall's Bootstrap UCL	35.46	95% Percentile Bootstrap UCL	35.38
95% BCA Bootstrap UCL	35.38		
90% Chebyshev(Mean, Sd) UCL	37.99	95% Chebyshev(Mean, Sd) UCL	40.48
97.5% Chebyshev(Mean, Sd) UCL	43.94	99% Chebyshev(Mean, Sd) UCL	50.74

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	40.48

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Vanadium

General Statistics

Total Number of Observations	60	Number of Distinct Observations	54
		Number of Missing Observations	0
Minimum	22.3	Mean	187.7
Maximum	584	Median	166

SD	112.6	Std. Error of Mean	14.54
Coefficient of Variation	0.6	Skewness	1.325

Normal GOF Test

Shapiro Wilk Test Statistic	0.902	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	5.1539E-5	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.108	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.114	Data appear Normal at 5% Significance Level	

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	212	95% Adjusted-CLT UCL (Chen-1995)	214.3
		95% Modified-t UCL (Johnson-1978)	212.4

Gamma GOF Test

A-D Test Statistic	0.971	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.76	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.144	**Kolmogrov-Smirnoff Gamma GOF Test**	
5% K-S Critical Value	0.116	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.584	k star (bias corrected MLE)	2.466
Theta hat (MLE)	72.64	Theta star (bias corrected MLE)	76.12
nu hat (MLE)	310.1	nu star (bias corrected)	295.9
MLE Mean (bias corrected)	187.7	MLE Sd (bias corrected)	119.5
		Approximate Chi Square Value (0.05)	257.1
Adjusted Level of Significance	0.046	Adjusted Chi Square Value	256.2

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	216.1	95% Adjusted Gamma UCL (use when n<50)	216.8

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.904	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	6.9784E-5	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.189	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.114	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.105	Mean of logged Data	5.029
Maximum of Logged Data	6.37	SD of logged Data	0.719

Assuming Lognormal Distribution

95% H-UCL	239.9	90% Chebyshev (MVUE) UCL	257.1
95% Chebyshev (MVUE) UCL	284.5	97.5% Chebyshev (MVUE) UCL	322.5
99% Chebyshev (MVUE) UCL	397		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	211.6	95% Jackknife UCL	212
95% Standard Bootstrap UCL	211.4	95% Bootstrap-t UCL	215.8
95% Hall's Bootstrap UCL	217.2	95% Percentile Bootstrap UCL	212.3
95% BCA Bootstrap UCL	213.9		
90% Chebyshev(Mean, Sd) UCL	231.3	95% Chebyshev(Mean, Sd) UCL	251.1
97.5% Chebyshev(Mean, Sd) UCL	278.5	99% Chebyshev(Mean, Sd) UCL	332.4

Suggested UCL to Use

95% Student's-t UCL 212

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Zinc

General Statistics

Total Number of Observations	60	Number of Distinct Observations	57
		Number of Missing Observations	0
Minimum	121	Mean	811.9
Maximum	1610	Median	867.5
SD	360.4	Std. Error of Mean	46.53
Coefficient of Variation	0.444	Skewness	-0.169

Normal GOF Test

Shapiro Wilk Test Statistic	0.961	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.117	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.115	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.114	Data Not Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	889.6	95% Adjusted-CLT UCL (Chen-1995)	887.3
		95% Modified-t UCL (Johnson-1978)	889.5

Gamma GOF Test

A-D Test Statistic	1.873	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.755	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.182	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.115	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.59	k star (bias corrected MLE)	3.421
Theta hat (MLE)	226.2	Theta star (bias corrected MLE)	237.3
nu hat (MLE)	430.8	nu star (bias corrected)	410.6
MLE Mean (bias corrected)	811.9	MLE Sd (bias corrected)	438.9
		Approximate Chi Square Value (0.05)	364.6
Adjusted Level of Significance	0.046	Adjusted Chi Square Value	363.5

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	914.3	95% Adjusted Gamma UCL (use when n<50)	916.9

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.843	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	2.2493E-8	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.206	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.114	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.796	Mean of logged Data	6.554
Maximum of Logged Data	7.384	SD of logged Data	0.622

Assuming Lognormal Distribution

95% H-UCL	999.1	90% Chebyshev (MVUE) UCL	1068
95% Chebyshev (MVUE) UCL	1168	97.5% Chebyshev (MVUE) UCL	1306
99% Chebyshev (MVUE) UCL	1578		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	888.4	95% Jackknife UCL	889.6
95% Standard Bootstrap UCL	886.8	95% Bootstrap-t UCL	887.1
95% Hall's Bootstrap UCL	889.7	95% Percentile Bootstrap UCL	885.9
95% BCA Bootstrap UCL	886.5		
90% Chebyshev(Mean, Sd) UCL	951.5	95% Chebyshev(Mean, Sd) UCL	1015
97.5% Chebyshev(Mean, Sd) UCL	1102	99% Chebyshev(Mean, Sd) UCL	1275

Suggested UCL to Use

95% Student's-t UCL	889.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Henry Site Upland Vegetation

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	4/5/2016 3:30:30 PM
From File	ProUCLinput-UPVEG.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Antimony+nonCS

General Statistics

Total Number of Observations	80	Number of Distinct Observations	21
		Number of Missing Observations	63
Number of Detects	1	Number of Non-Detects	79
Number of Distinct Detects	1	Number of Distinct Non-Detects	20

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!

It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Antimony+nonCS was not processed!

Arsenic+nonCS

General Statistics

Total Number of Observations	80	Number of Distinct Observations	75
		Number of Missing Observations	63
Number of Detects	65	Number of Non-Detects	15
Number of Distinct Detects	63	Number of Distinct Non-Detects	13
Minimum Detect	0.073	Minimum Non-Detect	0.0696
Maximum Detect	10.2	Maximum Non-Detect	0.075
Variance Detects	4.751	Percent Non-Detects	18.75%
Mean Detects	0.87	SD Detects	2.18
Median Detects	0.156	CV Detects	2.504
Skewness Detects	3.327	Kurtosis Detects	10.06
Mean of Logged Detects	-1.444	SD of Logged Detects	1.279

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.401	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.395	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.11	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.72	Standard Error of Mean	0.222
SD	1.975	95% KM (BCA) UCL	1.088

95% KM (t) UCL	1.091	95% KM (Percentile Bootstrap) UCL	1.118
95% KM (z) UCL	1.086	95% KM Bootstrap t UCL	1.271
90% KM Chebyshev UCL	1.388	95% KM Chebyshev UCL	1.69
97.5% KM Chebyshev UCL	2.11	99% KM Chebyshev UCL	2.934

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	10.12	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.819	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.293	**Kolmogrov-Smirnoff GOF**	
5% K-S Critical Value	0.117	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.489	k star (bias corrected MLE)	0.476
Theta hat (MLE)	1.782	Theta star (bias corrected MLE)	1.828
nu hat (MLE)	63.51	nu star (bias corrected)	61.91
MLE Mean (bias corrected)	0.87	MLE Sd (bias corrected)	1.261

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.133	nu hat (KM)	21.3
Approximate Chi Square Value (21.30, α)	11.81	Adjusted Chi Square Value (21.30, β)	11.68
95% Gamma Approximate KM-UCL (use when n>=50)	1.299	95% Gamma Adjusted KM-UCL (use when n<50)	1.313

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.709
Maximum	10.2	Median	0.12
SD	1.991	CV	2.808
k hat (MLE)	0.39	k star (bias corrected MLE)	0.384
Theta hat (MLE)	1.817	Theta star (bias corrected MLE)	1.847
nu hat (MLE)	62.45	nu star (bias corrected)	61.44
MLE Mean (bias corrected)	0.709	MLE Sd (bias corrected)	1.144
		Adjusted Level of Significance (β)	0.047
Approximate Chi Square Value (61.44, α)	44.41	Adjusted Chi Square Value (61.44, β)	44.15
95% Gamma Approximate UCL (use when n>=50)	0.981	95% Gamma Adjusted UCL (use when n<50)	0.987

Lognormal GOF Test on Detected Observations Only

Lilliefors Test Statistic	0.221	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.11	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.71	Mean in Log Scale	-1.933
SD in Original Scale	1.99	SD in Log Scale	1.544
95% t UCL (assumes normality of ROS data)	1.081	95% Percentile Bootstrap UCL	1.098

95% BCA Bootstrap UCL	1.197	95% Bootstrap t UCL	1.275
95% H-UCL (Log ROS)	0.785		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.714	Mean in Log Scale	-1.793
SD in Original Scale	1.989	SD in Log Scale	1.364
95% t UCL (Assumes normality)	1.084	95% H-Stat UCL	0.634

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	1.69

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Boron+nonCS

General Statistics

Total Number of Observations	80	Number of Distinct Observations	77
		Number of Missing Observations	63
Number of Detects	76	Number of Non-Detects	4
Number of Distinct Detects	74	Number of Distinct Non-Detects	3
Minimum Detect	2.5	Minimum Non-Detect	2.35
Maximum Detect	47.3	Maximum Non-Detect	2.46
Variance Detects	104.1	Percent Non-Detects	5%
Mean Detects	13.1	SD Detects	10.2
Median Detects	9.665	CV Detects	0.779
Skewness Detects	1.491	Kurtosis Detects	1.956
Mean of Logged Detects	2.3	SD of Logged Detects	0.748

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.834	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	9.730E-12	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.173	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.102	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	12.56	Standard Error of Mean	1.143
SD	10.15	95% KM (BCA) UCL	14.45
95% KM (t) UCL	14.46	95% KM (Percentile Bootstrap) UCL	14.43
95% KM (z) UCL	14.44	95% KM Bootstrap t UCL	14.77

90% KM Chebyshev UCL	15.99	95% KM Chebyshev UCL	17.54
97.5% KM Chebyshev UCL	19.69	99% KM Chebyshev UCL	23.93

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.783	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.763	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.0851	**Kolmogrov-Smirnoff GOF**	
5% K-S Critical Value	0.104	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.989	k star (bias corrected MLE)	1.919
Theta hat (MLE)	6.585	Theta star (bias corrected MLE)	6.824
nu hat (MLE)	302.3	nu star (bias corrected)	291.7
MLE Mean (bias corrected)	13.1	MLE Sd (bias corrected)	9.453

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	1.53	nu hat (KM)	244.8
Approximate Chi Square Value (244.84, α)	209.6	Adjusted Chi Square Value (244.84, β)	209
95% Gamma Approximate KM-UCL (use when n>=50)	14.67	95% Gamma Adjusted KM-UCL (use when n<50)	14.71

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	12.44
Maximum	47.3	Median	8.99
SD	10.35	CV	0.832
k hat (MLE)	1.018	k star (bias corrected MLE)	0.988
Theta hat (MLE)	12.23	Theta star (bias corrected MLE)	12.59
nu hat (MLE)	162.8	nu star (bias corrected)	158.1
MLE Mean (bias corrected)	12.44	MLE Sd (bias corrected)	12.52
		Adjusted Level of Significance (β)	0.047
Approximate Chi Square Value (158.05, α)	130	Adjusted Chi Square Value (158.05, β)	129.5
95% Gamma Approximate UCL (use when n>=50)	15.13	95% Gamma Adjusted UCL (use when n<50)	15.18

Lognormal GOF Test on Detected Observations Only

Lilliefors Test Statistic	0.0507	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.102	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	12.53	Mean in Log Scale	2.212
SD in Original Scale	10.25	SD in Log Scale	0.826
95% t UCL (assumes normality of ROS data)	14.43	95% Percentile Bootstrap UCL	14.32
95% BCA Bootstrap UCL	14.82	95% Bootstrap t UCL	14.7
95% H-UCL (Log ROS)	15.62		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	2.228	95% H-UCL (KM -Log)	15.24
KM SD (logged)	0.79	95% Critical H Value (KM-Log)	2.07
KM Standard Error of Mean (logged)	0.0889		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	12.5	Mean in Log Scale	2.195
SD in Original Scale	10.28	SD in Log Scale	0.863
95% t UCL (Assumes normality)	14.41	95% H-Stat UCL	16.04

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	17.54	95% GROS Approximate Gamma UCL	15.13
95% Approximate Gamma KM-UCL	14.67		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium+nonCS

General Statistics

Total Number of Observations	81	Number of Distinct Observations	78
		Number of Missing Observations	62
Minimum	0.254	Mean	1.4
Maximum	5.29	Median	1.15
SD	1	Std. Error of Mean	0.111
Coefficient of Variation	0.714	Skewness	2.118

Normal GOF Test

Shapiro Wilk Test Statistic	0.785	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	1.110E-16	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.17	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0984	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.585	95% Adjusted-CLT UCL (Chen-1995)	1.611
		95% Modified-t UCL (Johnson-1978)	1.59

Gamma GOF Test

A-D Test Statistic	1.073	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.76	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.0926	**Kolmogrov-Smirnoff Gamma GOF Test**	
5% K-S Critical Value	0.1	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.735	k star (bias corrected MLE)	2.642
Theta hat (MLE)	0.512	Theta star (bias corrected MLE)	0.53
nu hat (MLE)	443	nu star (bias corrected)	427.9
MLE Mean (bias corrected)	1.4	MLE Sd (bias corrected)	0.862
		Approximate Chi Square Value (0.05)	381
Adjusted Level of Significance	0.047	Adjusted Chi Square Value	380.2

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	1.573	95% Adjusted Gamma UCL (use when n<50)	1.576

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.982	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.677	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0578	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0984	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.37	Mean of logged Data	0.143
Maximum of Logged Data	1.666	SD of logged Data	0.612

Assuming Lognormal Distribution

95% H-UCL	1.585	90% Chebyshev (MVUE) UCL	1.692
95% Chebyshev (MVUE) UCL	1.83	97.5% Chebyshev (MVUE) UCL	2.022
99% Chebyshev (MVUE) UCL	2.399		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.583	95% Jackknife UCL	1.585
95% Standard Bootstrap UCL	1.584	95% Bootstrap-t UCL	1.626
95% Hall's Bootstrap UCL	1.624	95% Percentile Bootstrap UCL	1.587
95% BCA Bootstrap UCL	1.631		
90% Chebyshev(Mean, Sd) UCL	1.734	95% Chebyshev(Mean, Sd) UCL	1.885
97.5% Chebyshev(Mean, Sd) UCL	2.094	99% Chebyshev(Mean, Sd) UCL	2.506

Suggested UCL to Use

95% Approximate Gamma UCL	1.573

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Chromium+nonCS

General Statistics

Total Number of Observations	80	Number of Distinct Observations	71
		Number of Missing Observations	63
Minimum	1.38	Mean	2.943
Maximum	18.2	Median	2.395
SD	2.147	Std. Error of Mean	0.24
Coefficient of Variation	0.729	Skewness	5.023

Normal GOF Test

Shapiro Wilk Test Statistic	0.573	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.233	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0991	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	3.342	95% Adjusted-CLT UCL (Chen-1995)	3.481
		95% Modified-t UCL (Johnson-1978)	3.365

Gamma GOF Test

A-D Test Statistic	2.582	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.756	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.129	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.1	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.102	k star (bias corrected MLE)	3.957
Theta hat (MLE)	0.717	Theta star (bias corrected MLE)	0.744
nu hat (MLE)	656.3	nu star (bias corrected)	633
MLE Mean (bias corrected)	2.943	MLE Sd (bias corrected)	1.479
		Approximate Chi Square Value (0.05)	575.7
Adjusted Level of Significance	0.047	Adjusted Chi Square Value	574.7

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	3.236	95% Adjusted Gamma UCL (use when n<50)	3.241

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.912	**Shapiro Wilk Lognormal GOF Test**

5% Shapiro Wilk P Value	7.7324E-6	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0855	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0991	Data appear Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.322	Mean of logged Data	0.952
Maximum of Logged Data	2.901	SD of logged Data	0.45

Assuming Lognormal Distribution

95% H-UCL	3.146	90% Chebyshev (MVUE) UCL	3.315
95% Chebyshev (MVUE) UCL	3.52	97.5% Chebyshev (MVUE) UCL	3.803
99% Chebyshev (MVUE) UCL	4.361		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3.337	95% Jackknife UCL	3.342
95% Standard Bootstrap UCL	3.327	95% Bootstrap-t UCL	3.652
95% Hall's Bootstrap UCL	5.162	95% Percentile Bootstrap UCL	3.364
95% BCA Bootstrap UCL	3.548		
90% Chebyshev(Mean, Sd) UCL	3.663	95% Chebyshev(Mean, Sd) UCL	3.989
97.5% Chebyshev(Mean, Sd) UCL	4.441	99% Chebyshev(Mean, Sd) UCL	5.331

Suggested UCL to Use

95% Student's-t UCL	3.342	or 95% Modified-t UCL	3.365

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Cobalt+nonCS

General Statistics

Total Number of Observations	80	Number of Distinct Observations	24
		Number of Missing Observations	63
Number of Detects	6	Number of Non-Detects	74
Number of Distinct Detects	6	Number of Distinct Non-Detects	18
Minimum Detect	0.126	Minimum Non-Detect	0.115
Maximum Detect	0.298	Maximum Non-Detect	0.623
Variance Detects	0.00381	Percent Non-Detects	92.5%
Mean Detects	0.188	SD Detects	0.0617
Median Detects	0.167	CV Detects	0.329
Skewness Detects	1.362	Kurtosis Detects	1.736
Mean of Logged Detects	-1.713	SD of Logged Detects	0.303

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.882	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.273	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.362	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.121	Standard Error of Mean	0.00322
SD	0.0254	95% KM (BCA) UCL	0.128
95% KM (t) UCL	0.126	95% KM (Percentile Bootstrap) UCL	0.127
95% KM (z) UCL	0.126	95% KM Bootstrap t UCL	0.127
90% KM Chebyshev UCL	0.131	95% KM Chebyshev UCL	0.135
97.5% KM Chebyshev UCL	0.141	99% KM Chebyshev UCL	0.153

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.336	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.698	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.258	**Kolmogrov-Smirnoff GOF**	
5% K-S Critical Value	0.332	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	12.58	k star (bias corrected MLE)	6.402
Theta hat (MLE)	0.0149	Theta star (bias corrected MLE)	0.0293
nu hat (MLE)	151	nu star (bias corrected)	76.83
MLE Mean (bias corrected)	0.188	MLE Sd (bias corrected)	0.0742

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	22.64	nu hat (KM)	3623
Approximate Chi Square Value (N/A, α)	3484	Adjusted Chi Square Value (N/A, β)	3481
95% Gamma Approximate KM-UCL (use when n>=50)	0.126	95% Gamma Adjusted KM-UCL (use when n<50)	0.126

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0268
Maximum	0.298	Median	0.01
SD	0.05	CV	1.865
k hat (MLE)	0.938	k star (bias corrected MLE)	0.911
Theta hat (MLE)	0.0286	Theta star (bias corrected MLE)	0.0294
nu hat (MLE)	150	nu star (bias corrected)	145.7
MLE Mean (bias corrected)	0.0268	MLE Sd (bias corrected)	0.0281
		Adjusted Level of Significance (β)	0.047
Approximate Chi Square Value (145.73, α)	118.8	Adjusted Chi Square Value (145.73, β)	118.4
95% Gamma Approximate UCL (use when n>=50)	0.0329	95% Gamma Adjusted UCL (use when n<50)	0.033

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.945	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.236	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.362	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0524	Mean in Log Scale	-3.195
SD in Original Scale	0.0464	SD in Log Scale	0.667
95% t UCL (assumes normality of ROS data)	0.061	95% Percentile Bootstrap UCL	0.0612
95% BCA Bootstrap UCL	0.0634	95% Bootstrap t UCL	0.0641
95% H-UCL (Log ROS)	0.0593		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-2.127	95% H-UCL (KM -Log)	0.124
KM SD (logged)	0.145	95% Critical H Value (KM-Log)	1.691
KM Standard Error of Mean (logged)	0.0184		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0865	Mean in Log Scale	-2.607
SD in Original Scale	0.0684	SD in Log Scale	0.479
95% t UCL (Assumes normality)	0.0993	95% H-Stat UCL	0.0913

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.126	95% KM (Percentile Bootstrap) UCL	0.127

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper+nonCS

General Statistics

Total Number of Observations	81	Number of Distinct Observations	76
		Number of Missing Observations	62
Minimum	3.24	Mean	6.749
Maximum	15.4	Median	6.67
SD	2.167	Std. Error of Mean	0.241
Coefficient of Variation	0.321	Skewness	0.882

Normal GOF Test

Shapiro Wilk Test Statistic	0.948	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0.00584	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.0805	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0984	Data appear Normal at 5% Significance Level	

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	7.15	95% Adjusted-CLT UCL (Chen-1995)	7.171
		95% Modified-t UCL (Johnson-1978)	7.154

Gamma GOF Test

A-D Test Statistic	0.629	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.751	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.0958	**Kolmogrov-Smirnoff Gamma GOF Test**	
5% K-S Critical Value	0.0991	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	10.11	k star (bias corrected MLE)	9.748
Theta hat (MLE)	0.667	Theta star (bias corrected MLE)	0.692
nu hat (MLE)	1639	nu star (bias corrected)	1579
MLE Mean (bias corrected)	6.749	MLE Sd (bias corrected)	2.162
		Approximate Chi Square Value (0.05)	1488
Adjusted Level of Significance	0.047	Adjusted Chi Square Value	1486

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	7.163	95% Adjusted Gamma UCL (use when n<50)	7.171

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.967	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.135	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.117	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0984	Data Not Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.176	Mean of logged Data	1.859
Maximum of Logged Data	2.734	SD of logged Data	0.322

Assuming Lognormal Distribution

95% H-UCL	7.2	90% Chebyshev (MVUE) UCL	7.498
95% Chebyshev (MVUE) UCL	7.834	97.5% Chebyshev (MVUE) UCL	8.301
99% Chebyshev (MVUE) UCL	9.217		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	7.145	95% Jackknife UCL	7.15
95% Standard Bootstrap UCL	7.152	95% Bootstrap-t UCL	7.16
95% Hall's Bootstrap UCL	7.187	95% Percentile Bootstrap UCL	7.16
95% BCA Bootstrap UCL	7.177		
90% Chebyshev(Mean, Sd) UCL	7.472	95% Chebyshev(Mean, Sd) UCL	7.799
97.5% Chebyshev(Mean, Sd) UCL	8.253	99% Chebyshev(Mean, Sd) UCL	9.145

Suggested UCL to Use

95% Student's-t UCL	7.15

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Manganese+nonCS

General Statistics

Total Number of Observations	80	Number of Distinct Observations	72
		Number of Missing Observations	63
Minimum	8.99	Mean	26.52
Maximum	54.8	Median	26.05
SD	10.59	Std. Error of Mean	1.184
Coefficient of Variation	0.399	Skewness	0.6

Normal GOF Test

Shapiro Wilk Test Statistic	0.954	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.0177	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.09	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0991	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	28.49	95% Adjusted-CLT UCL (Chen-1995)	28.55
		95% Modified-t UCL (Johnson-1978)	28.5

Gamma GOF Test

A-D Test Statistic	0.183	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.753	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0595	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.0999	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	6.244	k star (bias corrected MLE)	6.018
Theta hat (MLE)	4.247	Theta star (bias corrected MLE)	4.406
nu hat (MLE)	999	nu star (bias corrected)	962.9
MLE Mean (bias corrected)	26.52	MLE Sd (bias corrected)	10.81
		Approximate Chi Square Value (0.05)	891.9
Adjusted Level of Significance	0.047	Adjusted Chi Square Value	890.6

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	28.63	95% Adjusted Gamma UCL (use when n<50)	28.67

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.97	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0.217	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0719	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.0991	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.196	Mean of logged Data	3.196
Maximum of Logged Data	4.004	SD of logged Data	0.418

Assuming Lognormal Distribution

95% H-UCL	29.03	90% Chebyshev (MVUE) UCL	30.5
95% Chebyshev (MVUE) UCL	32.26	97.5% Chebyshev (MVUE) UCL	34.7
99% Chebyshev (MVUE) UCL	39.49		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	28.47	95% Jackknife UCL	28.49
95% Standard Bootstrap UCL	28.42	95% Bootstrap-t UCL	28.61
95% Hall's Bootstrap UCL	28.55	95% Percentile Bootstrap UCL	28.4
95% BCA Bootstrap UCL	28.53		
90% Chebyshev(Mean, Sd) UCL	30.07	95% Chebyshev(Mean, Sd) UCL	31.68
97.5% Chebyshev(Mean, Sd) UCL	33.91	99% Chebyshev(Mean, Sd) UCL	38.3

Suggested UCL to Use

95% Student's-t UCL	28.49

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Mercury+nonCS

General Statistics

Total Number of Observations	80	Number of Distinct Observations	53
		Number of Missing Observations	63
Number of Detects	23	Number of Non-Detects	57
Number of Distinct Detects	22	Number of Distinct Non-Detects	33
Minimum Detect	0.00761	Minimum Non-Detect	0.00756
Maximum Detect	0.0687	Maximum Non-Detect	0.0493
Variance Detects	2.3682E-4	Percent Non-Detects	71.25%
Mean Detects	0.0192	SD Detects	0.0154
Median Detects	0.0124	CV Detects	0.802
Skewness Detects	2.096	Kurtosis Detects	4.253
Mean of Logged Detects	-4.165	SD of Logged Detects	0.612

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.714	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.914	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.262	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.185	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.0119	Standard Error of Mean	0.00112
SD	0.0095	95% KM (BCA) UCL	0.0139
95% KM (t) UCL	0.0138	95% KM (Percentile Bootstrap) UCL	0.0138
95% KM (z) UCL	0.0138	95% KM Bootstrap t UCL	0.0149
90% KM Chebyshev UCL	0.0153	95% KM Chebyshev UCL	0.0168
97.5% KM Chebyshev UCL	0.0189	99% KM Chebyshev UCL	0.0231

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.427	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.752	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.231	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.183	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.519	k star (bias corrected MLE)	2.219
Theta hat (MLE)	0.00762	Theta star (bias corrected MLE)	0.00864
nu hat (MLE)	115.9	nu star (bias corrected)	102.1
MLE Mean (bias corrected)	0.0192	MLE Sd (bias corrected)	0.0129

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	1.57	nu hat (KM)	251.2
Approximate Chi Square Value (251.20, α)	215.5	Adjusted Chi Square Value (251.20, β)	214.9
95% Gamma Approximate KM-UCL (use when n>=50)	0.0139	95% Gamma Adjusted KM-UCL (use when n<50)	0.0139

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.00761	Mean	0.0128
Maximum	0.0687	Median	0.01
SD	0.00912	CV	0.71
k hat (MLE)	4.862	k star (bias corrected MLE)	4.688
Theta hat (MLE)	0.00264	Theta star (bias corrected MLE)	0.00274
nu hat (MLE)	777.9	nu star (bias corrected)	750.1
MLE Mean (bias corrected)	0.0128	MLE Sd (bias corrected)	0.00593
		Adjusted Level of Significance (β)	0.047
Approximate Chi Square Value (750.07, α)	687.5	Adjusted Chi Square Value (750.07, β)	686.4
95% Gamma Approximate UCL (use when n>=50)	0.014	95% Gamma Adjusted UCL (use when n<50)	0.014

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.888	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.914	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.209	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.185	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0106	Mean in Log Scale	-4.767
SD in Original Scale	0.0101	SD in Log Scale	0.585
95% t UCL (assumes normality of ROS data)	0.0125	95% Percentile Bootstrap UCL	0.0125
95% BCA Bootstrap UCL	0.0131	95% Bootstrap t UCL	0.0135
95% H-UCL (Log ROS)	0.0115		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0112	Mean in Log Scale	-4.681
SD in Original Scale	0.00993	SD in Log Scale	0.551
95% t UCL (Assumes normality)	0.0131	95% H-Stat UCL	0.0121

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.0138	95% KM (% Bootstrap) UCL	0.0138

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Molybdenum+nonCS

General Statistics

Total Number of Observations	81	Number of Distinct Observations	76
		Number of Missing Observations	62
Number of Detects	80	Number of Non-Detects	1
Number of Distinct Detects	75	Number of Distinct Non-Detects	1
Minimum Detect	1.53	Minimum Non-Detect	1.46
Maximum Detect	125	Maximum Non-Detect	1.46
Variance Detects	509.9	Percent Non-Detects	1.235%
Mean Detects	16.71	SD Detects	22.58
Median Detects	8.805	CV Detects	1.351
Skewness Detects	3.007	Kurtosis Detects	9.852
Mean of Logged Detects	2.294	SD of Logged Detects	0.961

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.607	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.285	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0991	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	16.53	Standard Error of Mean	2.501
SD	22.36	95% KM (BCA) UCL	20.81
95% KM (t) UCL	20.69	95% KM (Percentile Bootstrap) UCL	20.71
95% KM (z) UCL	20.64	95% KM Bootstrap t UCL	22.16
90% KM Chebyshev UCL	24.03	95% KM Chebyshev UCL	27.43
97.5% KM Chebyshev UCL	32.14	99% KM Chebyshev UCL	41.41

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	3.364	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.78	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.186	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.103	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.094	k star (bias corrected MLE)	1.061
Theta hat (MLE)	15.28	Theta star (bias corrected MLE)	15.75
nu hat (MLE)	175	nu star (bias corrected)	169.8
MLE Mean (bias corrected)	16.71	MLE Sd (bias corrected)	16.22

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.546	nu hat (KM)	88.46
Approximate Chi Square Value (88.46, α)	67.77	Adjusted Chi Square Value (88.46, β)	67.45
95% Gamma Approximate KM-UCL (use when n>=50)	21.57	95% Gamma Adjusted KM-UCL (use when n<50)	21.67

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	16.51
Maximum	125	Median	8.72
SD	22.52	CV	1.364
k hat (MLE)	0.973	k star (bias corrected MLE)	0.945
Theta hat (MLE)	16.96	Theta star (bias corrected MLE)	17.46
nu hat (MLE)	157.7	nu star (bias corrected)	153.2
MLE Mean (bias corrected)	16.51	MLE Sd (bias corrected)	16.98
		Adjusted Level of Significance (β)	0.047
Approximate Chi Square Value (153.16, α)	125.5	Adjusted Chi Square Value (153.16, β)	125.1
95% Gamma Approximate UCL (use when n>=50)	20.14	95% Gamma Adjusted UCL (use when n<50)	20.21

Lognormal GOF Test on Detected Observations Only

Lilliefors Test Statistic	0.105	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0991	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	16.52	Mean in Log Scale	2.262
SD in Original Scale	22.51	SD in Log Scale	0.997
95% t UCL (assumes normality of ROS data)	20.68	95% Percentile Bootstrap UCL	20.77
95% BCA Bootstrap UCL	21.58	95% Bootstrap t UCL	22.26
95% H-UCL (Log ROS)	20.25		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	16.52	Mean in Log Scale	2.262
SD in Original Scale	22.51	SD in Log Scale	0.998
95% t UCL (Assumes normality)	20.68	95% H-Stat UCL	20.27

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (BCA) UCL	20.81

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel+nonCS

General Statistics

Total Number of Observations	80	Number of Distinct Observations	74
		Number of Missing Observations	63
Minimum	0.705	Mean	4.203
Maximum	17.4	Median	3.615
SD	2.822	Std. Error of Mean	0.316
Coefficient of Variation	0.672	Skewness	2.5

Normal GOF Test

Shapiro Wilk Test Statistic	0.781	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.173	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0991	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	4.728	95% Adjusted-CLT UCL (Chen-1995)	4.816
		95% Modified-t UCL (Johnson-1978)	4.743

Gamma GOF Test

A-D Test Statistic	0.877	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.758	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0912	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.1	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.153	k star (bias corrected MLE)	3.043
Theta hat (MLE)	1.333	Theta star (bias corrected MLE)	1.381
nu hat (MLE)	504.5	nu star (bias corrected)	486.9
MLE Mean (bias corrected)	4.203	MLE Sd (bias corrected)	2.409
		Approximate Chi Square Value (0.05)	436.8
Adjusted Level of Significance	0.047	Adjusted Chi Square Value	435.9

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	4.686	95% Adjusted Gamma UCL (use when n<50)	4.695

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.989	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0.95	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0568	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.0991	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.35	Mean of logged Data	1.269
Maximum of Logged Data	2.856	SD of logged Data	0.569

Assuming Lognormal Distribution

95% H-UCL	4.726	90% Chebyshev (MVUE) UCL	5.026
95% Chebyshev (MVUE) UCL	5.412	97.5% Chebyshev (MVUE) UCL	5.948
99% Chebyshev (MVUE) UCL	7		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	4.722	95% Jackknife UCL	4.728
95% Standard Bootstrap UCL	4.722	95% Bootstrap-t UCL	4.859
95% Hall's Bootstrap UCL	4.879	95% Percentile Bootstrap UCL	4.713
95% BCA Bootstrap UCL	4.803		
90% Chebyshev(Mean, Sd) UCL	5.15	95% Chebyshev(Mean, Sd) UCL	5.578
97.5% Chebyshev(Mean, Sd) UCL	6.174	99% Chebyshev(Mean, Sd) UCL	7.343

Suggested UCL to Use

95% Approximate Gamma UCL	4.686

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Selenium+nonCS

General Statistics

Total Number of Observations	138	Number of Distinct Observations	91
		Number of Missing Observations	5
Number of Detects	91	Number of Non-Detects	47
Number of Distinct Detects	90	Number of Distinct Non-Detects	2
Minimum Detect	0.451	Minimum Non-Detect	0.5
Maximum Detect	146	Maximum Non-Detect	0.6
Variance Detects	791.6	Percent Non-Detects	34.06%
Mean Detects	12.12	SD Detects	28.14
Median Detects	2.49	CV Detects	2.322
Skewness Detects	3.543	Kurtosis Detects	12.85
Mean of Logged Detects	1.203	SD of Logged Detects	1.4

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.447	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.385	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0929	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	8.149	Standard Error of Mean	2.002
SD	23.38	95% KM (BCA) UCL	11.66
95% KM (t) UCL	11.46	95% KM (Percentile Bootstrap) UCL	11.62
95% KM (z) UCL	11.44	95% KM Bootstrap t UCL	12.97
90% KM Chebyshev UCL	14.15	95% KM Chebyshev UCL	16.87
97.5% KM Chebyshev UCL	20.65	99% KM Chebyshev UCL	28.06

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	8.899	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.82	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.241	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.0992	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.493	k star (bias corrected MLE)	0.484
Theta hat (MLE)	24.6	Theta star (bias corrected MLE)	25.05
nu hat (MLE)	89.67	nu star (bias corrected)	88.05
MLE Mean (bias corrected)	12.12	MLE Sd (bias corrected)	17.42

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.121	nu hat (KM)	33.52
Approximate Chi Square Value (33.52, α)	21.28	Adjusted Chi Square Value (33.52, β)	21.18
95% Gamma Approximate KM-UCL (use when n>=50)	12.84	95% Gamma Adjusted KM-UCL (use when n<50)	12.9

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	7.995
Maximum	146	Median	1.18
SD	23.52	CV	2.942
k hat (MLE)	0.249	k star (bias corrected MLE)	0.248
Theta hat (MLE)	32.11	Theta star (bias corrected MLE)	32.18
nu hat (MLE)	68.73	nu star (bias corrected)	68.57
MLE Mean (bias corrected)	7.995	MLE Sd (bias corrected)	16.04
		Adjusted Level of Significance (β)	0.0483
Approximate Chi Square Value (68.57, α)	50.51	Adjusted Chi Square Value (68.57, β)	50.35
95% Gamma Approximate UCL (use when n>=50)	10.85	95% Gamma Adjusted UCL (use when n<50)	10.89

Lognormal GOF Test on Detected Observations Only

Lilliefors Test Statistic	0.11	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0929	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	8.061	Mean in Log Scale	0.129
SD in Original Scale	23.5	SD in Log Scale	1.968
95% t UCL (assumes normality of ROS data)	11.37	95% Percentile Bootstrap UCL	11.26
95% BCA Bootstrap UCL	12.51	95% Bootstrap t UCL	13
95% H-UCL (Log ROS)	13.6		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	8.077	Mean in Log Scale	0.322
SD in Original Scale	23.49	SD in Log Scale	1.673
95% t UCL (Assumes normality)	11.39	95% H-Stat UCL	8.462

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	16.87

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Silver+nonCS

General Statistics

Total Number of Observations	80	Number of Distinct Observations	37
		Number of Missing Observations	63
Number of Detects	5	Number of Non-Detects	75
Number of Distinct Detects	5	Number of Distinct Non-Detects	32
Minimum Detect	0.0546	Minimum Non-Detect	0.0459
Maximum Detect	0.164	Maximum Non-Detect	0.089
Variance Detects	0.00171	Percent Non-Detects	93.75%
Mean Detects	0.0937	SD Detects	0.0414
Median Detects	0.0835	CV Detects	0.442
Skewness Detects	1.666	Kurtosis Detects	3.458
Mean of Logged Detects	-2.435	SD of Logged Detects	0.397

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.824	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.354	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.396	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.0489	Standard Error of Mean	0.00186
SD	0.0148	95% KM (BCA) UCL	0.0525
95% KM (t) UCL	0.052	95% KM (Percentile Bootstrap) UCL	0.0522
95% KM (z) UCL	0.052	95% KM Bootstrap t UCL	0.0519
90% KM Chebyshev UCL	0.0545	95% KM Chebyshev UCL	0.057
97.5% KM Chebyshev UCL	0.0605	99% KM Chebyshev UCL	0.0674

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.45	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.68	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.318	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	7.583	k star (bias corrected MLE)	3.166
Theta hat (MLE)	0.0124	Theta star (bias corrected MLE)	0.0296
nu hat (MLE)	75.83	nu star (bias corrected)	31.66
MLE Mean (bias corrected)	0.0937	MLE Sd (bias corrected)	0.0526

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	10.88	nu hat (KM)	1740
Approximate Chi Square Value (N/A, α)	1644	Adjusted Chi Square Value (N/A, β)	1642
95% Gamma Approximate KM-UCL (use when n>=50)	0.0518	95% Gamma Adjusted KM-UCL (use when n<50)	0.0518

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0152
Maximum	0.164	Median	0.01
SD	0.0224	CV	1.471
k hat (MLE)	1.904	k star (bias corrected MLE)	1.841
Theta hat (MLE)	0.008	Theta star (bias corrected MLE)	0.00827
nu hat (MLE)	304.6	nu star (bias corrected)	294.5
MLE Mean (bias corrected)	0.0152	MLE Sd (bias corrected)	0.0112
		Adjusted Level of Significance (β)	0.047
Approximate Chi Square Value (294.51, α)	255.8	Adjusted Chi Square Value (294.51, β)	255.1
95% Gamma Approximate UCL (use when n>=50)	0.0175	95% Gamma Adjusted UCL (use when n<50)	0.0176

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.913	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.294	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.396	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0159	Mean in Log Scale	-4.55
SD in Original Scale	0.023	SD in Log Scale	0.779
95% t UCL (assumes normality of ROS data)	0.0201	95% Percentile Bootstrap UCL	0.0205
95% BCA Bootstrap UCL	0.0218	95% Bootstrap t UCL	0.0228
95% H-UCL (Log ROS)	0.0171		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-3.041	95% H-UCL (KM -Log)	0.0503
KM SD (logged)	0.18	95% Critical H Value (KM-Log)	1.702
KM Standard Error of Mean (logged)	0.0226		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.029	Mean in Log Scale	-3.626
SD in Original Scale	0.0194	SD in Log Scale	0.33
95% t UCL (Assumes normality)	0.0326	95% H-Stat UCL	0.03

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.052	95% KM (Percentile Bootstrap) UCL	0.0522

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Thallium+nonCS

General Statistics

Total Number of Observations	80	Number of Distinct Observations	73
		Number of Missing Observations	63
Number of Detects	79	Number of Non-Detects	1
Number of Distinct Detects	72	Number of Distinct Non-Detects	1
Minimum Detect	0.013	Minimum Non-Detect	0.01
Maximum Detect	0.713	Maximum Non-Detect	0.01
Variance Detects	0.0177	Percent Non-Detects	1.25%
Mean Detects	0.187	SD Detects	0.133
Median Detects	0.161	CV Detects	0.712
Skewness Detects	1.599	Kurtosis Detects	3.78
Mean of Logged Detects	-1.949	SD of Logged Detects	0.815

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.878	**Normal GOF Test on Detected Observations Only**

5% Shapiro Wilk P Value	1.1429E-8	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.136	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0997	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.185	Standard Error of Mean	0.0149
SD	0.133	95% KM (BCA) UCL	0.209
95% KM (t) UCL	0.209	95% KM (Percentile Bootstrap) UCL	0.209
95% KM (z) UCL	0.209	95% KM Bootstrap t UCL	0.212
90% KM Chebyshev UCL	0.229	95% KM Chebyshev UCL	0.25
97.5% KM Chebyshev UCL	0.278	99% KM Chebyshev UCL	0.333

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.439	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.763	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0958	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.102	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.995	k star (bias corrected MLE)	1.928
Theta hat (MLE)	0.0937	Theta star (bias corrected MLE)	0.0969
nu hat (MLE)	315.2	nu star (bias corrected)	304.6
MLE Mean (bias corrected)	0.187	MLE Sd (bias corrected)	0.135

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	1.934	nu hat (KM)	309.5
Approximate Chi Square Value (309.51, α)	269.8	Adjusted Chi Square Value (309.51, β)	269.1
95% Gamma Approximate KM-UCL (use when n>=50)	0.212	95% Gamma Adjusted KM-UCL (use when n<50)	0.212

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.185
Maximum	0.713	Median	0.16
SD	0.134	CV	0.724
k hat (MLE)	1.859	k star (bias corrected MLE)	1.798
Theta hat (MLE)	0.0993	Theta star (bias corrected MLE)	0.103
nu hat (MLE)	297.5	nu star (bias corrected)	287.7
MLE Mean (bias corrected)	0.185	MLE Sd (bias corrected)	0.138
		Adjusted Level of Significance (β)	0.047
Approximate Chi Square Value (287.69, α)	249.4	Adjusted Chi Square Value (287.69, β)	248.8
95% Gamma Approximate UCL (use when n>=50)	0.213	95% Gamma Adjusted UCL (use when n<50)	0.214

Lognormal GOF Test on Detected Observations Only

Lilliefors Test Statistic	0.143	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0997	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.185	Mean in Log Scale	-1.975
SD in Original Scale	0.133	SD in Log Scale	0.844
95% t UCL (assumes normality of ROS data)	0.21	95% Percentile Bootstrap UCL	0.21
95% BCA Bootstrap UCL	0.212	95% Bootstrap t UCL	0.214
95% H-UCL (Log ROS)	0.242		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.185	Mean in Log Scale	-1.99
SD in Original Scale	0.134	SD in Log Scale	0.892
95% t UCL (Assumes normality)	0.209	95% H-Stat UCL	0.253

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.25	95% GROS Approximate Gamma UCL	0.213
95% Approximate Gamma KM-UCL	0.212		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Uranium+nonCS

General Statistics

Total Number of Observations	80	Number of Distinct Observations	37
		Number of Missing Observations	63
Number of Detects	7	Number of Non-Detects	73
Number of Distinct Detects	7	Number of Distinct Non-Detects	30
Minimum Detect	0.157	Minimum Non-Detect	0.0917
Maximum Detect	1.27	Maximum Non-Detect	0.178
Variance Detects	0.162	Percent Non-Detects	91.25%
Mean Detects	0.373	SD Detects	0.402
Median Detects	0.207	CV Detects	1.077
Skewness Detects	2.472	Kurtosis Detects	6.261
Mean of Logged Detects	-1.29	SD of Logged Detects	0.739

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.607	**Shapiro Wilk GOF Test**	

5% Shapiro Wilk Critical Value	0.803	Detected Data Not Normal at 5% Significance Level			
Lilliefors Test Statistic	0.375	**Lilliefors GOF Test**			
5% Lilliefors Critical Value	0.335	Detected Data Not Normal at 5% Significance Level			

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.116	Standard Error of Mean	0.0164
SD	0.136	95% KM (BCA) UCL	0.148
95% KM (t) UCL	0.144	95% KM (Percentile Bootstrap) UCL	0.146
95% KM (z) UCL	0.143	95% KM Bootstrap t UCL	0.192
90% KM Chebyshev UCL	0.166	95% KM Chebyshev UCL	0.188
97.5% KM Chebyshev UCL	0.219	99% KM Chebyshev UCL	0.28

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.932	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.718	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.283	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.316	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.789	k star (bias corrected MLE)	1.118
Theta hat (MLE)	0.209	Theta star (bias corrected MLE)	0.334
nu hat (MLE)	25.05	nu star (bias corrected)	15.65
MLE Mean (bias corrected)	0.373	MLE Sd (bias corrected)	0.353

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.734	nu hat (KM)	117.4
Approximate Chi Square Value (117.41, α)	93.39	Adjusted Chi Square Value (117.41, β)	93
95% Gamma Approximate KM-UCL (use when n>=50)	0.146	95% Gamma Adjusted KM-UCL (use when n<50)	0.147

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0418
Maximum	1.27	Median	0.01
SD	0.151	CV	3.625
k hat (MLE)	0.549	k star (bias corrected MLE)	0.537
Theta hat (MLE)	0.0761	Theta star (bias corrected MLE)	0.0778
nu hat (MLE)	87.88	nu star (bias corrected)	85.92
MLE Mean (bias corrected)	0.0418	MLE Sd (bias corrected)	0.057
		Adjusted Level of Significance (β)	0.047
Approximate Chi Square Value (85.92, α)	65.55	Adjusted Chi Square Value (85.92, β)	65.22
95% Gamma Approximate UCL (use when n>=50)	0.0548	95% Gamma Adjusted UCL (use when n<50)	0.055

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.786	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.803	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.224	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.335	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0401	Mean in Log Scale	-4.95
SD in Original Scale	0.152	SD in Log Scale	1.53
95% t UCL (assumes normality of ROS data)	0.0684	95% Percentile Bootstrap UCL	0.0721
95% BCA Bootstrap UCL	0.0881	95% Bootstrap t UCL	0.124
95% H-UCL (Log ROS)	0.0373		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-2.293	95% H-UCL (KM -Log)	0.117
KM SD (logged)	0.371	95% Critical H Value (KM-Log)	1.784
KM Standard Error of Mean (logged)	0.0448		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0777	Mean in Log Scale	-2.861
SD in Original Scale	0.144	SD in Log Scale	0.535
95% t UCL (Assumes normality)	0.105	95% H-Stat UCL	0.0739

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.144	95% GROS Approximate Gamma UCL	0.0548
95% Approximate Gamma KM-UCL	0.146		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Vanadium+nonCS

General Statistics

Total Number of Observations	80	Number of Distinct Observations	76
		Number of Missing Observations	63
Number of Detects	79	Number of Non-Detects	1
Number of Distinct Detects	75	Number of Distinct Non-Detects	1
Minimum Detect	0.269	Minimum Non-Detect	0.618
Maximum Detect	13.1	Maximum Non-Detect	0.618
Variance Detects	2.205	Percent Non-Detects	1.25%

Mean Detects	0.937	SD Detects	1.485
Median Detects	0.625	CV Detects	1.585
Skewness Detects	7.291	Kurtosis Detects	59.3
Mean of Logged Detects	-0.374	SD of Logged Detects	0.637

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.356	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.326	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0997	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.931	Standard Error of Mean	0.165
SD	1.467	95% KM (BCA) UCL	1.237
95% KM (t) UCL	1.206	95% KM (Percentile Bootstrap) UCL	1.233
95% KM (z) UCL	1.202	95% KM Bootstrap t UCL	1.666
90% KM Chebyshev UCL	1.426	95% KM Chebyshev UCL	1.65
97.5% KM Chebyshev UCL	1.962	99% KM Chebyshev UCL	2.574

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	4.72	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.766	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.185	**Kolmogrov-Smirnoff GOF**	
5% K-S Critical Value	0.102	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.768	k star (bias corrected MLE)	1.709
Theta hat (MLE)	0.53	Theta star (bias corrected MLE)	0.548
nu hat (MLE)	279.4	nu star (bias corrected)	270.1
MLE Mean (bias corrected)	0.937	MLE Sd (bias corrected)	0.717

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.402	nu hat (KM)	64.37
Approximate Chi Square Value (64.37, α)	46.91	Adjusted Chi Square Value (64.37, β)	46.64
95% Gamma Approximate KM-UCL (use when n>=50)	1.277	95% Gamma Adjusted KM-UCL (use when n<50)	1.285

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.171	Mean	0.927
Maximum	13.1	Median	0.61
SD	1.478	CV	1.594
k hat (MLE)	1.731	k star (bias corrected MLE)	1.675
Theta hat (MLE)	0.536	Theta star (bias corrected MLE)	0.554

nu hat (MLE)	277	nu star (bias corrected)	267.9
MLE Mean (bias corrected)	0.927	MLE Sd (bias corrected)	0.717
		Adjusted Level of Significance (β)	0.047
Approximate Chi Square Value (267.93, α)	231	Adjusted Chi Square Value (267.93, β)	230.4
95% Gamma Approximate UCL (use when n>=50)	1.075	95% Gamma Adjusted UCL (use when n<50)	1.078

Lognormal GOF Test on Detected Observations Only

Lilliefors Test Statistic	0.104	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0997	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.931	Mean in Log Scale	-0.379
SD in Original Scale	1.477	SD in Log Scale	0.635
95% t UCL (assumes normality of ROS data)	1.206	95% Percentile Bootstrap UCL	1.24
95% BCA Bootstrap UCL	1.422	95% Bootstrap t UCL	1.661
95% H-UCL (Log ROS)	0.962		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.929	Mean in Log Scale	-0.384
SD in Original Scale	1.477	SD in Log Scale	0.639
95% t UCL (Assumes normality)	1.204	95% H-Stat UCL	0.961

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (BCA) UCL 1.237

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zinc+nonCS

General Statistics

Total Number of Observations	81	Number of Distinct Observations	74
		Number of Missing Observations	62
Minimum	17.3	Mean	49.96
Maximum	109	Median	46.8
SD	17.44	Std. Error of Mean	1.938
Coefficient of Variation	0.349	Skewness	0.65

Normal GOF Test

Shapiro Wilk Test Statistic	0.966	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0.11	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.0781	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0984	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	53.19	95% Adjusted-CLT UCL (Chen-1995)	53.3
		95% Modified-t UCL (Johnson-1978)	53.21

Gamma GOF Test

A-D Test Statistic	0.257	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.752	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.0536	**Kolmogrov-Smirnoff Gamma GOF Test**	
5% K-S Critical Value	0.0992	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	8.335	k star (bias corrected MLE)	8.035
Theta hat (MLE)	5.994	Theta star (bias corrected MLE)	6.218
nu hat (MLE)	1350	nu star (bias corrected)	1302
MLE Mean (bias corrected)	49.96	MLE Sd (bias corrected)	17.63
		Approximate Chi Square Value (0.05)	1219
Adjusted Level of Significance	0.047	Adjusted Chi Square Value	1217

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	53.36	95% Adjusted Gamma UCL (use when n<50)	53.42

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.984	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.777	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0699	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0984	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.851	Mean of logged Data	3.85
Maximum of Logged Data	4.691	SD of logged Data	0.358

Assuming Lognormal Distribution

95% H-UCL	53.77	90% Chebyshev (MVUE) UCL	56.19
95% Chebyshev (MVUE) UCL	58.97	97.5% Chebyshev (MVUE) UCL	62.83
99% Chebyshev (MVUE) UCL	70.41		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	53.15	95% Jackknife UCL	53.19
95% Standard Bootstrap UCL	53.16	95% Bootstrap-t UCL	53.44
95% Hall's Bootstrap UCL	53.32	95% Percentile Bootstrap UCL	53.3
95% BCA Bootstrap UCL	53.25		
90% Chebyshev(Mean, Sd) UCL	55.78	95% Chebyshev(Mean, Sd) UCL	58.41
97.5% Chebyshev(Mean, Sd) UCL	62.07	99% Chebyshev(Mean, Sd) UCL	69.25

Suggested UCL to Use

95% Student's-t UCL 53.19

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Arsenic+CS

General Statistics

Total Number of Observations	5	Number of Distinct Observations	4
		Number of Missing Observations	121
Number of Detects	2	Number of Non-Detects	3
Number of Distinct Detects	2	Number of Distinct Non-Detects	2
Minimum Detect	0.111	Minimum Non-Detect	0.074
Maximum Detect	0.135	Maximum Non-Detect	0.37
Variance Detects	2.8800E-4	Percent Non-Detects	60%
Mean Detects	0.123	SD Detects	0.017
Median Detects	0.123	CV Detects	0.138
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	-2.1	SD of Logged Detects	0.138

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only

Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.107	Standard Error of Mean	0.0205
SD	0.0251	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.15	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.14	95% KM Bootstrap t UCL	N/A

90% KM Chebyshev UCL	0.168	95% KM Chebyshev UCL	0.196
97.5% KM Chebyshev UCL	0.235	99% KM Chebyshev UCL	0.311

Gamma GOF Tests on Detected Observations Only

Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	104.7	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.00117	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	418.9	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	18.07	nu hat (KM)	180.7
		Adjusted Level of Significance (β)	0.0086
Approximate Chi Square Value (180.73, α)	150.6	Adjusted Chi Square Value (180.73, β)	138.6
95% Gamma Approximate KM-UCL (use when n>=50)	0.128	95% Gamma Adjusted KM-UCL (use when n<50)	0.139

Lognormal GOF Test on Detected Observations Only

Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.108	Mean in Log Scale	-2.246
SD in Original Scale	0.0225	SD in Log Scale	0.216
95% t UCL (assumes normality of ROS data)	0.129	95% Percentile Bootstrap UCL	0.123
95% BCA Bootstrap UCL	0.122	95% Bootstrap t UCL	0.127
95% H-UCL (Log ROS)	0.138		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.131	Mean in Log Scale	-2.174
SD in Original Scale	0.0614	SD in Log Scale	0.664
95% t UCL (Assumes normality)	0.189	95% H-Stat UCL	0.457

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.15	95% KM (% Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!

Warning: Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Boron+CS

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	121
Minimum	13.2	Mean	25.78
Maximum	42.2	Median	25.4
SD	11.37	Std. Error of Mean	5.085
Coefficient of Variation	0.441	Skewness	0.565

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.969	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.164	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	36.62	95% Adjusted-CLT UCL (Chen-1995)	35.52
		95% Modified-t UCL (Johnson-1978)	36.84

Gamma GOF Test

A-D Test Statistic	0.186	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.68	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.178	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	6.335	k star (bias corrected MLE)	2.667
Theta hat (MLE)	4.069	Theta star (bias corrected MLE)	9.665
nu hat (MLE)	63.35	nu star (bias corrected)	26.67
MLE Mean (bias corrected)	25.78	MLE Sd (bias corrected)	15.78
		Approximate Chi Square Value (0.05)	15.9
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	12.41

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	43.25	95% Adjusted Gamma UCL (use when n<50)	55.4

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.984	**Shapiro Wilk Lognormal GOF Test**

5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.158	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.58	Mean of logged Data	3.169
Maximum of Logged Data	3.742	SD of logged Data	0.456

Assuming Lognormal Distribution

95% H-UCL	50.09	90% Chebyshev (MVUE) UCL	41.49
95% Chebyshev (MVUE) UCL	48.59	97.5% Chebyshev (MVUE) UCL	58.44
99% Chebyshev (MVUE) UCL	77.81		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	34.14	95% Jackknife UCL	36.62
95% Standard Bootstrap UCL	33.18	95% Bootstrap-t UCL	38.4
95% Hall's Bootstrap UCL	38.55	95% Percentile Bootstrap UCL	33.92
95% BCA Bootstrap UCL	33.92		
90% Chebyshev(Mean, Sd) UCL	41.04	95% Chebyshev(Mean, Sd) UCL	47.95
97.5% Chebyshev(Mean, Sd) UCL	57.54	99% Chebyshev(Mean, Sd) UCL	76.38

Suggested UCL to Use

95% Student's-t UCL	36.62

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Cadmium+CS

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	121
Minimum	0.132	Mean	2.479
Maximum	5.56	Median	1.2
SD	2.705	Std. Error of Mean	1.21
Coefficient of Variation	1.091	Skewness	0.515

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.791	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.282	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	5.058	95% Adjusted-CLT UCL (Chen-1995)	4.767
		95% Modified-t UCL (Johnson-1978)	5.104

Gamma GOF Test

A-D Test Statistic	0.423	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.701	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.263	**Kolmogrov-Smirnoff Gamma GOF Test**	
5% K-S Critical Value	0.368	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.69	k star (bias corrected MLE)	0.409
Theta hat (MLE)	3.591	Theta star (bias corrected MLE)	6.054
nu hat (MLE)	6.903	nu star (bias corrected)	4.095
MLE Mean (bias corrected)	2.479	MLE Sd (bias corrected)	3.874
		Approximate Chi Square Value (0.05)	0.759
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	0.317

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	13.37	95% Adjusted Gamma UCL (use when n<50)	32.05

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.884	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.229	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-2.025	Mean of logged Data	0.0306
Maximum of Logged Data	1.716	SD of logged Data	1.712

Assuming Lognormal Distribution

95% H-UCL	4487	90% Chebyshev (MVUE) UCL	8.441
95% Chebyshev (MVUE) UCL	10.99	97.5% Chebyshev (MVUE) UCL	14.53
99% Chebyshev (MVUE) UCL	21.47		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	4.469	95% Jackknife UCL	5.058
95% Standard Bootstrap UCL	4.281	95% Bootstrap-t UCL	11.55
95% Hall's Bootstrap UCL	10.15	95% Percentile Bootstrap UCL	4.436
95% BCA Bootstrap UCL	4.412		
90% Chebyshev(Mean, Sd) UCL	6.108	95% Chebyshev(Mean, Sd) UCL	7.752
97.5% Chebyshev(Mean, Sd) UCL	10.03	99% Chebyshev(Mean, Sd) UCL	14.52

Suggested UCL to Use

95% Student's-t UCL	5.058

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Chromium+CS

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	121
Minimum	1.49	Mean	1.952
Maximum	2.81	Median	1.75
SD	0.544	Std. Error of Mean	0.243
Coefficient of Variation	0.279	Skewness	1.223

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.879	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.245	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.471	95% Adjusted-CLT UCL (Chen-1995)	2.494
		95% Modified-t UCL (Johnson-1978)	2.493

Gamma GOF Test

A-D Test Statistic	0.354	**Anderson-Darling Gamma GOF Test**

5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.245	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.357	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	17.7	k star (bias corrected MLE)	7.215
Theta hat (MLE)	0.11	Theta star (bias corrected MLE)	0.271
nu hat (MLE)	177	nu star (bias corrected)	72.15
MLE Mean (bias corrected)	1.952	MLE Sd (bias corrected)	0.727
		Approximate Chi Square Value (0.05)	53.59
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	46.67

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.628	95% Adjusted Gamma UCL (use when n<50)	3.018

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.912	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.221	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.399	Mean of logged Data	0.64
Maximum of Logged Data	1.033	SD of logged Data	0.261

Assuming Lognormal Distribution

95% H-UCL	2.657	90% Chebyshev (MVUE) UCL	2.631
95% Chebyshev (MVUE) UCL	2.94	97.5% Chebyshev (MVUE) UCL	3.369
99% Chebyshev (MVUE) UCL	4.211		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.352	95% Jackknife UCL	2.471
95% Standard Bootstrap UCL	2.3	95% Bootstrap-t UCL	3.444
95% Hall's Bootstrap UCL	4.584	95% Percentile Bootstrap UCL	2.334
95% BCA Bootstrap UCL	2.414		
90% Chebyshev(Mean, Sd) UCL	2.682	95% Chebyshev(Mean, Sd) UCL	3.012
97.5% Chebyshev(Mean, Sd) UCL	3.471	99% Chebyshev(Mean, Sd) UCL	4.372

Suggested UCL to Use

95% Student's-t UCL	2.471

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)

and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.

For additional insight the user may want to consult a statistician.

Cobalt+CS

General Statistics

Total Number of Observations	5	Number of Distinct Observations	4
		Number of Missing Observations	121
Number of Detects	1	Number of Non-Detects	4
Number of Distinct Detects	1	Number of Distinct Non-Detects	3

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!

It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Cobalt+CS was not processed!

Copper+CS

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	121
Minimum	3.66	Mean	5.876
Maximum	7.2	Median	6.1
SD	1.42	Std. Error of Mean	0.635
Coefficient of Variation	0.242	Skewness	-1.07

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.914	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.185	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	7.23	95% Adjusted-CLT UCL (Chen-1995)	6.596
		95% Modified-t UCL (Johnson-1978)	7.179

Gamma GOF Test

A-D Test Statistic	0.382	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.679	Detected data appear Gamma Distributed at 5% Significance Level

K-S Test Statistic	0.208	**Kolmogrov-Smirnoff Gamma GOF Test**	
5% K-S Critical Value	0.357	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	18.42	k star (bias corrected MLE)	7.503
Theta hat (MLE)	0.319	Theta star (bias corrected MLE)	0.783
nu hat (MLE)	184.2	nu star (bias corrected)	75.03
MLE Mean (bias corrected)	5.876	MLE Sd (bias corrected)	2.145
		Approximate Chi Square Value (0.05)	56.08
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	48.98

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	7.862	95% Adjusted Gamma UCL (use when n<50)	9.001

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.869	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.233	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.297	Mean of logged Data	1.743
Maximum of Logged Data	1.974	SD of logged Data	0.273

Assuming Lognormal Distribution

95% H-UCL	8.164	90% Chebyshev (MVUE) UCL	8.037
95% Chebyshev (MVUE) UCL	9.01	97.5% Chebyshev (MVUE) UCL	10.36
99% Chebyshev (MVUE) UCL	13.01		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	6.92	95% Jackknife UCL	7.23
95% Standard Bootstrap UCL	6.803	95% Bootstrap-t UCL	6.878
95% Hall's Bootstrap UCL	6.505	95% Percentile Bootstrap UCL	6.756
95% BCA Bootstrap UCL	6.584		
90% Chebyshev(Mean, Sd) UCL	7.781	95% Chebyshev(Mean, Sd) UCL	8.643
97.5% Chebyshev(Mean, Sd) UCL	9.841	99% Chebyshev(Mean, Sd) UCL	12.19

Suggested UCL to Use

95% Student's-t UCL	7.23

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Manganese+CS

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	121
Minimum	20.7	Mean	43.28
Maximum	70.1	Median	32.5
SD	21.77	Std. Error of Mean	9.734
Coefficient of Variation	0.503	Skewness	0.476

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.873	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.29	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	64.03	95% Adjusted-CLT UCL (Chen-1995)	61.5
		95% Modified-t UCL (Johnson-1978)	64.38

Gamma GOF Test

A-D Test Statistic	0.401	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.681	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.274	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.913	k star (bias corrected MLE)	2.099
Theta hat (MLE)	8.809	Theta star (bias corrected MLE)	20.62
nu hat (MLE)	49.13	nu star (bias corrected)	20.99
MLE Mean (bias corrected)	43.28	MLE Sd (bias corrected)	29.88
		Approximate Chi Square Value (0.05)	11.58

Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	8.689

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	78.43	95% Adjusted Gamma UCL (use when n<50)	104.5

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.91	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.237	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.03	Mean of logged Data	3.662
Maximum of Logged Data	4.25	SD of logged Data	0.517

Assuming Lognormal Distribution

95% H-UCL	96.73	90% Chebyshev (MVUE) UCL	72.99
95% Chebyshev (MVUE) UCL	86.46	97.5% Chebyshev (MVUE) UCL	105.1
99% Chebyshev (MVUE) UCL	141.8		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	59.29	95% Jackknife UCL	64.03
95% Standard Bootstrap UCL	57.35	95% Bootstrap-t UCL	105.4
95% Hall's Bootstrap UCL	308	95% Percentile Bootstrap UCL	59.22
95% BCA Bootstrap UCL	59.22		
90% Chebyshev(Mean, Sd) UCL	72.48	95% Chebyshev(Mean, Sd) UCL	85.71
97.5% Chebyshev(Mean, Sd) UCL	104.1	99% Chebyshev(Mean, Sd) UCL	140.1

Suggested UCL to Use

95% Student's-t UCL	64.03

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Mercury+CS

General Statistics

Total Number of Observations	5	Number of Distinct Observations	4
		Number of Missing Observations	121
Number of Detects	1	Number of Non-Detects	4
Number of Distinct Detects	1	Number of Distinct Non-Detects	3

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Mercury+CS was not processed!

Molybdenum+CS

General Statistics

Total Number of Observations	5	Number of Distinct Observations	3
		Number of Missing Observations	121
Number of Detects	1	Number of Non-Detects	4
Number of Distinct Detects	1	Number of Distinct Non-Detects	2

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Molybdenum+CS was not processed!

Nickel+CS

General Statistics

Total Number of Observations	5	Number of Distinct Observations	4
		Number of Missing Observations	121
Number of Detects	3	Number of Non-Detects	2
Number of Distinct Detects	3	Number of Distinct Non-Detects	1
Minimum Detect	1.06	Minimum Non-Detect	0.986
Maximum Detect	4.58	Maximum Non-Detect	0.986
Variance Detects	3.77	Percent Non-Detects	40%
Mean Detects	2.347	SD Detects	1.942
Median Detects	1.4	CV Detects	0.827
Skewness Detects	1.672	Kurtosis Detects	N/A
Mean of Logged Detects	0.639	SD of Logged Detects	0.777

Warning: Data set has only 3 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.822	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.767	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.354	**Lilliefors GOF Test**

5% Lilliefors Critical Value	0.512	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	1.802	Standard Error of Mean	0.765
SD	1.397	95% KM (BCA) UCL	N/A
95% KM (t) UCL	3.434	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	3.061	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	4.098	95% KM Chebyshev UCL	5.138
97.5% KM Chebyshev UCL	6.582	99% KM Chebyshev UCL	9.417

Gamma GOF Tests on Detected Observations Only

Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	2.488	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.943	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	14.93	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	1.664	nu hat (KM)	16.64
		Adjusted Level of Significance (β)	0.0086
Approximate Chi Square Value (16.64, α)	8.416	Adjusted Chi Square Value (16.64, β)	6.032
95% Gamma Approximate KM-UCL (use when n>=50)	3.564	95% Gamma Adjusted KM-UCL (use when n<50)	4.972

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.886	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.767	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.318	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.512	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.487	Mean in Log Scale	-0.298
SD in Original Scale	1.81	SD in Log Scale	1.424
95% t UCL (assumes normality of ROS data)	3.212	95% Percentile Bootstrap UCL	2.797
95% BCA Bootstrap UCL	3.082	95% Bootstrap t UCL	5.034
95% H-UCL (Log ROS)	255.8		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	0.378	95% H-UCL (KM -Log)	4.478
KM SD (logged)	0.586	95% Critical H Value (KM-Log)	3.238
KM Standard Error of Mean (logged)	0.321		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.605	Mean in Log Scale	0.1

SD in Original Scale	1.708	SD in Log Scale	0.92
95% t UCL (Assumes normality)	3.233	95% H-Stat UCL	13.74

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	3.434	95% KM (Percentile Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Selenium+CS

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	121
Minimum	0.504	Mean	1.883
Maximum	5.26	Median	1.23
SD	1.955	Std. Error of Mean	0.874
Coefficient of Variation	1.038	Skewness	1.88

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.772	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.321	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	3.747	95% Adjusted-CLT UCL (Chen-1995)	4.106
		95% Modified-t UCL (Johnson-1978)	3.869

Gamma GOF Test

A-D Test Statistic	0.359	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.686	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.218	**Kolmogrov-Smirnoff Gamma GOF Test**

5% K-S Critical Value	0.362	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.497	k star (bias corrected MLE)	0.732
Theta hat (MLE)	1.258	Theta star (bias corrected MLE)	2.572
nu hat (MLE)	14.97	nu star (bias corrected)	7.323
MLE Mean (bias corrected)	1.883	MLE Sd (bias corrected)	2.201
		Approximate Chi Square Value (0.05)	2.349
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	1.31

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	5.87	95% Adjusted Gamma UCL (use when n<50)	10.53

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.944	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.176	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.685	Mean of logged Data	0.263
Maximum of Logged Data	1.66	SD of logged Data	0.929

Assuming Lognormal Distribution

95% H-UCL	16.94	90% Chebyshev (MVUE) UCL	3.974
95% Chebyshev (MVUE) UCL	4.957	97.5% Chebyshev (MVUE) UCL	6.321
99% Chebyshev (MVUE) UCL	9.001		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3.321	95% Jackknife UCL	3.747
95% Standard Bootstrap UCL	3.187	95% Bootstrap-t UCL	7.622
95% Hall's Bootstrap UCL	9.21	95% Percentile Bootstrap UCL	3.172
95% BCA Bootstrap UCL	3.641		
90% Chebyshev(Mean, Sd) UCL	4.506	95% Chebyshev(Mean, Sd) UCL	5.693
97.5% Chebyshev(Mean, Sd) UCL	7.342	99% Chebyshev(Mean, Sd) UCL	10.58

Suggested UCL to Use

95% Student's-t UCL	3.747

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Vanadium+CS

General Statistics

Total Number of Observations	5	Number of Distinct Observations	4
		Number of Missing Observations	121
Number of Detects	3	Number of Non-Detects	2
Number of Distinct Detects	3	Number of Distinct Non-Detects	1
Minimum Detect	0.454	Minimum Non-Detect	0.616
Maximum Detect	1.09	Maximum Non-Detect	0.616
Variance Detects	0.101	Percent Non-Detects	40%
Mean Detects	0.767	SD Detects	0.318
Median Detects	0.758	CV Detects	0.415
Skewness Detects	0.132	Kurtosis Detects	N/A
Mean of Logged Detects	-0.327	SD of Logged Detects	0.44

Warning: Data set has only 3 Detected Values.

This is not enough to compute meaningful or reliable statistics and estimates.

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.999	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.767	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.178	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.512	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.642	Standard Error of Mean	0.139
SD	0.253	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.937	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.87	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	1.058	95% KM Chebyshev UCL	1.246
97.5% KM Chebyshev UCL	1.508	99% KM Chebyshev UCL	2.021

Gamma GOF Tests on Detected Observations Only

Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	8.225	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.0933	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	49.35	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	6.436	nu hat (KM)	64.36
		Adjusted Level of Significance (β)	0.0086
Approximate Chi Square Value (64.36, α)	46.9	Adjusted Chi Square Value (64.36, β)	40.47
95% Gamma Approximate KM-UCL (use when n>=50)	0.881	95% Gamma Adjusted KM-UCL (use when n<50)	1.021

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.99	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.767	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.212	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.512	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.638	Mean in Log Scale	-0.524
SD in Original Scale	0.29	SD in Log Scale	0.426
95% t UCL (assumes normality of ROS data)	0.915	95% Percentile Bootstrap UCL	0.842
95% BCA Bootstrap UCL	0.891	95% Bootstrap t UCL	1.459
95% H-UCL (Log ROS)	1.158		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-0.512	95% H-UCL (KM -Log)	1.009
KM SD (logged)	0.359	95% Critical H Value (KM-Log)	2.543
KM Standard Error of Mean (logged)	0.197		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.584	Mean in Log Scale	-0.667
SD in Original Scale	0.337	SD in Log Scale	0.56
95% t UCL (Assumes normality)	0.905	95% H-Stat UCL	1.45

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.937	95% KM (Percentile Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zinc+CS

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	121
Minimum	12.8	Mean	79.98
Maximum	231	Median	49.6
SD	90.07	Std. Error of Mean	40.28
Coefficient of Variation	1.126	Skewness	1.627

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.819	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.254	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	165.8	95% Adjusted-CLT UCL (Chen-1995)	177.5
		95% Modified-t UCL (Johnson-1978)	170.7

Gamma GOF Test

A-D Test Statistic	0.29	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.691	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.229	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.364	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.049	k star (bias corrected MLE)	0.553
Theta hat (MLE)	76.22	Theta star (bias corrected MLE)	144.6
nu hat (MLE)	10.49	nu star (bias corrected)	5.531
MLE Mean (bias corrected)	79.98	MLE Sd (bias corrected)	107.5
		Approximate Chi Square Value (0.05)	1.405
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	0.687

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	314.9	95% Adjusted Gamma UCL (use when n<50)	643.5

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.942	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level

Lilliefors Test Statistic	0.211	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.396	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.549	Mean of logged Data	3.835
Maximum of Logged Data	5.442	SD of logged Data	1.206

Assuming Lognormal Distribution

95% H-UCL	3177	90% Chebyshev (MVUE) UCL	198.8
95% Chebyshev (MVUE) UCL	253.1	97.5% Chebyshev (MVUE) UCL	328.4
99% Chebyshev (MVUE) UCL	476.4		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	146.2	95% Jackknife UCL	165.8
95% Standard Bootstrap UCL	139.2	95% Bootstrap-t UCL	317.9
95% Hall's Bootstrap UCL	493.4	95% Percentile Bootstrap UCL	144.4
95% BCA Bootstrap UCL	159.9		
90% Chebyshev(Mean, Sd) UCL	200.8	95% Chebyshev(Mean, Sd) UCL	255.6
97.5% Chebyshev(Mean, Sd) UCL	331.5	99% Chebyshev(Mean, Sd) UCL	480.7

Suggested UCL to Use

95% Student's-t UCL	165.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Antimony

General Statistics

Total Number of Observations	85	Number of Distinct Observations	21
		Number of Missing Observations	58
Number of Detects	1	Number of Non-Detects	84
Number of Distinct Detects	1	Number of Distinct Non-Detects	20

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Antimony was not processed!

Arsenic

General Statistics

Total Number of Observations	85	Number of Distinct Observations	78
		Number of Missing Observations	58
Number of Detects	67	Number of Non-Detects	18
Number of Distinct Detects	65	Number of Distinct Non-Detects	14
Minimum Detect	0.073	Minimum Non-Detect	0.0696
Maximum Detect	10.2	Maximum Non-Detect	0.37
Variance Detects	4.624	Percent Non-Detects	21.18%
Mean Detects	0.848	SD Detects	2.15
Median Detects	0.154	CV Detects	2.536
Skewness Detects	3.388	Kurtosis Detects	10.49
Mean of Logged Detects	-1.463	SD of Logged Detects	1.265

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.395	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.398	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.108	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.685	Standard Error of Mean	0.21
SD	1.921	95% KM (BCA) UCL	1.097
95% KM (t) UCL	1.034	95% KM (Percentile Bootstrap) UCL	1.079
95% KM (z) UCL	1.03	95% KM Bootstrap t UCL	1.234
90% KM Chebyshev UCL	1.314	95% KM Chebyshev UCL	1.6
97.5% KM Chebyshev UCL	1.996	99% KM Chebyshev UCL	2.773

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	10.67	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.819	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.299	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.115	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.491	k star (bias corrected MLE)	0.479
Theta hat (MLE)	1.729	Theta star (bias corrected MLE)	1.772
nu hat (MLE)	65.74	nu star (bias corrected)	64.13
MLE Mean (bias corrected)	0.848	MLE Sd (bias corrected)	1.226

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.127	nu hat (KM)	21.6
Approximate Chi Square Value (21.60, α)	12.04	Adjusted Chi Square Value (21.60, β)	11.91
95% Gamma Approximate KM-UCL (use when n>=50)	1.228	95% Gamma Adjusted KM-UCL (use when n<50)	1.241

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.671
Maximum	10.2	Median	0.114
SD	1.937	CV	2.888
k hat (MLE)	0.383	k star (bias corrected MLE)	0.378
Theta hat (MLE)	1.75	Theta star (bias corrected MLE)	1.776
nu hat (MLE)	65.15	nu star (bias corrected)	64.18
MLE Mean (bias corrected)	0.671	MLE Sd (bias corrected)	1.091
		Adjusted Level of Significance (β)	0.0472
Approximate Chi Square Value (64.18, α)	46.75	Adjusted Chi Square Value (64.18, β)	46.49
95% Gamma Approximate UCL (use when n>=50)	0.921	95% Gamma Adjusted UCL (use when n<50)	0.926

Lognormal GOF Test on Detected Observations Only

Lilliefors Test Statistic	0.226	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.108	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.675	Mean in Log Scale	-1.966
SD in Original Scale	1.936	SD in Log Scale	1.511
95% t UCL (assumes normality of ROS data)	1.024	95% Percentile Bootstrap UCL	1.03
95% BCA Bootstrap UCL	1.145	95% Bootstrap t UCL	1.22
95% H-UCL (Log ROS)	0.693		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.68	Mean in Log Scale	-1.815
SD in Original Scale	1.934	SD in Log Scale	1.334
95% t UCL (Assumes normality)	1.029	95% H-Stat UCL	0.577

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	1.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Boron

General Statistics

Total Number of Observations	85	Number of Distinct Observations	81
		Number of Missing Observations	58
Number of Detects	81	Number of Non-Detects	4
Number of Distinct Detects	78	Number of Distinct Non-Detects	3
Minimum Detect	2.5	Minimum Non-Detect	2.35
Maximum Detect	47.3	Maximum Non-Detect	2.46
Variance Detects	113.5	Percent Non-Detects	4.706%
Mean Detects	13.88	SD Detects	10.65
Median Detects	10.5	CV Detects	0.768
Skewness Detects	1.337	Kurtosis Detects	1.294
Mean of Logged Detects	2.354	SD of Logged Detects	0.761

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.847	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	1.280E-11	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.161	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0984	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	13.34	Standard Error of Mean	1.159
SD	10.62	95% KM (BCA) UCL	15.34
95% KM (t) UCL	15.26	95% KM (Percentile Bootstrap) UCL	15.34
95% KM (z) UCL	15.24	95% KM Bootstrap t UCL	15.48
90% KM Chebyshev UCL	16.81	95% KM Chebyshev UCL	18.39
97.5% KM Chebyshev UCL	20.57	99% KM Chebyshev UCL	24.87

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.74	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.764	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0799	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.101	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.959	k star (bias corrected MLE)	1.894
Theta hat (MLE)	7.086	Theta star (bias corrected MLE)	7.326
nu hat (MLE)	317.3	nu star (bias corrected)	306.9
MLE Mean (bias corrected)	13.88	MLE Sd (bias corrected)	10.08

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	1.577	nu hat (KM)	268.1
Approximate Chi Square Value (268.13, α)	231.2	Adjusted Chi Square Value (268.13, β)	230.6
95% Gamma Approximate KM-UCL (use when n>=50)	15.47	95% Gamma Adjusted KM-UCL (use when n<50)	15.5

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	13.23
Maximum	47.3	Median	9.96
SD	10.81	CV	0.817
k hat (MLE)	1.034	k star (bias corrected MLE)	1.006
Theta hat (MLE)	12.79	Theta star (bias corrected MLE)	13.15
nu hat (MLE)	175.9	nu star (bias corrected)	171
MLE Mean (bias corrected)	13.23	MLE Sd (bias corrected)	13.19
		Adjusted Level of Significance (β)	0.0472
Approximate Chi Square Value (170.98, α)	141.7	Adjusted Chi Square Value (170.98, β)	141.3
95% Gamma Approximate UCL (use when n>=50)	15.95	95% Gamma Adjusted UCL (use when n<50)	16.01

Lognormal GOF Test on Detected Observations Only

Lilliefors Test Statistic	0.0499	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0984	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	13.31	Mean in Log Scale	2.269
SD in Original Scale	10.71	SD in Log Scale	0.837
95% t UCL (assumes normality of ROS data)	15.24	95% Percentile Bootstrap UCL	15.3
95% BCA Bootstrap UCL	15.47	95% Bootstrap t UCL	15.47
95% H-UCL (Log ROS)	16.6		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	2.283	95% H-UCL (KM -Log)	16.23
KM SD (logged)	0.804	95% Critical H Value (KM-Log)	2.063
KM Standard Error of Mean (logged)	0.0877		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	13.28	Mean in Log Scale	2.252
SD in Original Scale	10.74	SD in Log Scale	0.874
95% t UCL (Assumes normality)	15.22	95% H-Stat UCL	17.04

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	18.39	95% GROS Approximate Gamma UCL	15.95
95% Approximate Gamma KM-UCL	15.47		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium

General Statistics

Total Number of Observations	86	Number of Distinct Observations	83
		Number of Missing Observations	57
Minimum	0.132	Mean	1.463
Maximum	5.56	Median	1.15
SD	1.162	Std. Error of Mean	0.125
Coefficient of Variation	0.794	Skewness	2.066

Normal GOF Test

Shapiro Wilk Test Statistic	0.762	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.187	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0955	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1.671	95% Adjusted-CLT UCL (Chen-1995)	1.699
		95% Modified-t UCL (Johnson-1978)	1.676

Gamma GOF Test

A-D Test Statistic	1.38	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.763	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.103	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.0976	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.2	k star (bias corrected MLE)	2.131
Theta hat (MLE)	0.665	Theta star (bias corrected MLE)	0.687
nu hat (MLE)	378.4	nu star (bias corrected)	366.5
MLE Mean (bias corrected)	1.463	MLE Sd (bias corrected)	1.002
		Approximate Chi Square Value (0.05)	323.1
Adjusted Level of Significance	0.0472	Adjusted Chi Square Value	322.5

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.659	95% Adjusted Gamma UCL (use when n<50)	1.663

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.978	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0.484	Data appear Lognormal at 5% Significance Level

Lilliefors Test Statistic	0.061	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0955	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-2.025	Mean of logged Data	0.136
Maximum of Logged Data	1.716	SD of logged Data	0.7

Assuming Lognormal Distribution

95% H-UCL	1.706	90% Chebyshev (MVUE) UCL	1.824
95% Chebyshev (MVUE) UCL	1.99	97.5% Chebyshev (MVUE) UCL	2.219
99% Chebyshev (MVUE) UCL	2.669		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.669	95% Jackknife UCL	1.671
95% Standard Bootstrap UCL	1.668	95% Bootstrap-t UCL	1.708
95% Hall's Bootstrap UCL	1.708	95% Percentile Bootstrap UCL	1.673
95% BCA Bootstrap UCL	1.693		
90% Chebyshev(Mean, Sd) UCL	1.839	95% Chebyshev(Mean, Sd) UCL	2.009
97.5% Chebyshev(Mean, Sd) UCL	2.245	99% Chebyshev(Mean, Sd) UCL	2.71

Suggested UCL to Use

95% H-UCL	1.706

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Chromium

General Statistics

Total Number of Observations	85	Number of Distinct Observations	74
		Number of Missing Observations	58
Minimum	1.38	Mean	2.884
Maximum	18.2	Median	2.36
SD	2.098	Std. Error of Mean	0.228
Coefficient of Variation	0.727	Skewness	5.125

Normal GOF Test

Shapiro Wilk Test Statistic	0.57	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.237	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0961	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	3.263	95% Adjusted-CLT UCL (Chen-1995)	3.394
		95% Modified-t UCL (Johnson-1978)	3.284

Gamma GOF Test

A-D Test Statistic	2.807	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.756	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.133	**Kolmogrov-Smirnoff Gamma GOF Test**	
5% K-S Critical Value	0.0973	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.154	k star (bias corrected MLE)	4.015
Theta hat (MLE)	0.694	Theta star (bias corrected MLE)	0.718
nu hat (MLE)	706.1	nu star (bias corrected)	682.6
MLE Mean (bias corrected)	2.884	MLE Sd (bias corrected)	1.439
		Approximate Chi Square Value (0.05)	622.9
Adjusted Level of Significance	0.0472	Adjusted Chi Square Value	622

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	3.16	95% Adjusted Gamma UCL (use when n<50)	3.165

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.909	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	1.4829E-6	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0879	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0961	Data appear Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.322	Mean of logged Data	0.934
Maximum of Logged Data	2.901	SD of logged Data	0.446

Assuming Lognormal Distribution

95% H-UCL	3.071	90% Chebyshev (MVUE) UCL	3.233
95% Chebyshev (MVUE) UCL	3.426	97.5% Chebyshev (MVUE) UCL	3.693
99% Chebyshev (MVUE) UCL	4.218		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3.259	95% Jackknife UCL	3.263
95% Standard Bootstrap UCL	3.258	95% Bootstrap-t UCL	3.527
95% Hall's Bootstrap UCL	5.021	95% Percentile Bootstrap UCL	3.285
95% BCA Bootstrap UCL	3.465		
90% Chebyshev(Mean, Sd) UCL	3.567	95% Chebyshev(Mean, Sd) UCL	3.876
97.5% Chebyshev(Mean, Sd) UCL	4.306	99% Chebyshev(Mean, Sd) UCL	5.149

Suggested UCL to Use

95% Student's-t UCL	3.263	or 95% Modified-t UCL	3.284

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Cobalt

General Statistics

Total Number of Observations	85	Number of Distinct Observations	25
		Number of Missing Observations	58
Number of Detects	7	Number of Non-Detects	78
Number of Distinct Detects	7	Number of Distinct Non-Detects	18
Minimum Detect	0.126	Minimum Non-Detect	0.115
Maximum Detect	0.502	Maximum Non-Detect	0.623
Variance Detects	0.0173	Percent Non-Detects	91.76%
Mean Detects	0.233	SD Detects	0.131
Median Detects	0.171	CV Detects	0.565
Skewness Detects	1.798	Kurtosis Detects	3.184
Mean of Logged Detects	-1.567	SD of Logged Detects	0.476

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.79	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.261	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.335	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.126	Standard Error of Mean	0.00607
SD	0.0496	95% KM (BCA) UCL	0.137
95% KM (t) UCL	0.136	95% KM (Percentile Bootstrap) UCL	0.136
95% KM (z) UCL	0.136	95% KM Bootstrap t UCL	0.148
90% KM Chebyshev UCL	0.144	95% KM Chebyshev UCL	0.152
97.5% KM Chebyshev UCL	0.164	99% KM Chebyshev UCL	0.186

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.503	**Anderson-Darling GOF Test**		
5% A-D Critical Value	0.71	Detected data appear Gamma Distributed at 5% Significance Level		
K-S Test Statistic	0.257	**Kolmogrov-Smirnoff GOF**		
5% K-S Critical Value	0.313	Detected data appear Gamma Distributed at 5% Significance Level		

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	4.769	k star (bias corrected MLE)	2.821
Theta hat (MLE)	0.0488	Theta star (bias corrected MLE)	0.0825
nu hat (MLE)	66.77	nu star (bias corrected)	39.49
MLE Mean (bias corrected)	0.233	MLE Sd (bias corrected)	0.138

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	6.409	nu hat (KM)	1090
Approximate Chi Square Value (N/A, α)	1014	Adjusted Chi Square Value (N/A, β)	1013
95% Gamma Approximate KM-UCL (use when n>=50)	0.135	95% Gamma Adjusted KM-UCL (use when n<50)	0.135

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0283
Maximum	0.502	Median	0.01
SD	0.0709	CV	2.502
k hat (MLE)	0.756	k star (bias corrected MLE)	0.737
Theta hat (MLE)	0.0375	Theta star (bias corrected MLE)	0.0384
nu hat (MLE)	128.5	nu star (bias corrected)	125.3
MLE Mean (bias corrected)	0.0283	MLE Sd (bias corrected)	0.033
		Adjusted Level of Significance (β)	0.0472
Approximate Chi Square Value (125.30, α)	100.4	Adjusted Chi Square Value (125.30, β)	100.1
95% Gamma Approximate UCL (use when n>=50)	0.0353	95% Gamma Adjusted UCL (use when n<50)	0.0355

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.902	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.234	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.335	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0406	Mean in Log Scale	-3.871
SD in Original Scale	0.07	SD in Log Scale	1.075
95% t UCL (assumes normality of ROS data)	0.0532	95% Percentile Bootstrap UCL	0.0543
95% BCA Bootstrap UCL	0.0583	95% Bootstrap t UCL	0.0617
95% H-UCL (Log ROS)	0.0487		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-2.109	95% H-UCL (KM -Log)	0.129
KM SD (logged)	0.216	95% Critical H Value (KM-Log)	1.71
KM Standard Error of Mean (logged)	0.0264		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.096	Mean in Log Scale	-2.555
SD in Original Scale	0.0869	SD in Log Scale	0.553
95% t UCL (Assumes normality)	0.112	95% H-Stat UCL	0.101

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.136	95% KM (Percentile Bootstrap) UCL	0.136

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper

General Statistics

Total Number of Observations	86	Number of Distinct Observations	81
		Number of Missing Observations	57
Minimum	3.24	Mean	6.699
Maximum	15.4	Median	6.66
SD	2.134	Std. Error of Mean	0.23
Coefficient of Variation	0.319	Skewness	0.901

Normal GOF Test

Shapiro Wilk Test Statistic	0.946	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.00323	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.0827	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0955	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	7.081	95% Adjusted-CLT UCL (Chen-1995)	7.101
		95% Modified-t UCL (Johnson-1978)	7.085

Gamma GOF Test

A-D Test Statistic	0.685	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.751	Detected data appear Gamma Distributed at 5% Significance Level

K-S Test Statistic	0.0909	**Kolmogrov-Smirnoff Gamma GOF Test**	
5% K-S Critical Value	0.0963	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	10.28	k star (bias corrected MLE)	9.93
Theta hat (MLE)	0.652	Theta star (bias corrected MLE)	0.675
nu hat (MLE)	1768	nu star (bias corrected)	1708
MLE Mean (bias corrected)	6.699	MLE Sd (bias corrected)	2.126
		Approximate Chi Square Value (0.05)	1613
Adjusted Level of Significance	0.0472	Adjusted Chi Square Value	1611

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	7.093	95% Adjusted Gamma UCL (use when n<50)	7.1

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.966	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.103	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.111	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0955	Data Not Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.176	Mean of logged Data	1.852
Maximum of Logged Data	2.734	SD of logged Data	0.319

Assuming Lognormal Distribution

95% H-UCL	7.128	90% Chebyshev (MVUE) UCL	7.413
95% Chebyshev (MVUE) UCL	7.733	97.5% Chebyshev (MVUE) UCL	8.179
99% Chebyshev (MVUE) UCL	9.053		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	7.077	95% Jackknife UCL	7.081
95% Standard Bootstrap UCL	7.074	95% Bootstrap-t UCL	7.109
95% Hall's Bootstrap UCL	7.126	95% Percentile Bootstrap UCL	7.067
95% BCA Bootstrap UCL	7.091		
90% Chebyshev(Mean, Sd) UCL	7.389	95% Chebyshev(Mean, Sd) UCL	7.702
97.5% Chebyshev(Mean, Sd) UCL	8.136	99% Chebyshev(Mean, Sd) UCL	8.989

Suggested UCL to Use

95% Student's-t UCL	7.081

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.

For additional insight the user may want to consult a statistician.

Manganese

General Statistics

Total Number of Observations	85	Number of Distinct Observations	76
		Number of Missing Observations	58
Minimum	8.99	Mean	27.5
Maximum	70.1	Median	26.6
SD	11.99	Std. Error of Mean	1.301
Coefficient of Variation	0.436	Skewness	1.058

Normal GOF Test

Shapiro Wilk Test Statistic	0.933	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	2.2698E-4	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.0911	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0961	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	29.67	95% Adjusted-CLT UCL (Chen-1995)	29.8
		95% Modified-t UCL (Johnson-1978)	29.69

Gamma GOF Test

A-D Test Statistic	0.197	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.754	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0563	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.0972	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.641	k star (bias corrected MLE)	5.449
Theta hat (MLE)	4.876	Theta star (bias corrected MLE)	5.047
nu hat (MLE)	958.9	nu star (bias corrected)	926.4
MLE Mean (bias corrected)	27.5	MLE Sd (bias corrected)	11.78
		Approximate Chi Square Value (0.05)	856.7
Adjusted Level of Significance	0.0472	Adjusted Chi Square Value	855.6

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	29.74	95% Adjusted Gamma UCL (use when n<50)	29.78

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.982	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0.659	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0615	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.0961	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.196	Mean of logged Data	3.223
Maximum of Logged Data	4.25	SD of logged Data	0.435

Assuming Lognormal Distribution

95% H-UCL	30.07	90% Chebyshev (MVUE) UCL	31.63
95% Chebyshev (MVUE) UCL	33.47	97.5% Chebyshev (MVUE) UCL	36.03
99% Chebyshev (MVUE) UCL	41.05		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	29.64	95% Jackknife UCL	29.67
95% Standard Bootstrap UCL	29.63	95% Bootstrap-t UCL	29.7
95% Hall's Bootstrap UCL	29.94	95% Percentile Bootstrap UCL	29.65
95% BCA Bootstrap UCL	29.68		
90% Chebyshev(Mean, Sd) UCL	31.41	95% Chebyshev(Mean, Sd) UCL	33.17
97.5% Chebyshev(Mean, Sd) UCL	35.63	99% Chebyshev(Mean, Sd) UCL	40.45

Suggested UCL to Use

95% Student's-t UCL	29.67

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Mercury

General Statistics

Total Number of Observations	85	Number of Distinct Observations	56
		Number of Missing Observations	58
Number of Detects	24	Number of Non-Detects	61
Number of Distinct Detects	23	Number of Distinct Non-Detects	35
Minimum Detect	0.00761	Minimum Non-Detect	0.00756
Maximum Detect	0.0687	Maximum Non-Detect	0.0493
Variance Detects	2.4322E-4	Percent Non-Detects	71.76%
Mean Detects	0.02	SD Detects	0.0156
Median Detects	0.0124	CV Detects	0.779
Skewness Detects	1.843	Kurtosis Detects	3.136
Mean of Logged Detects	-4.127	SD of Logged Detects	0.627

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.752	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.916	Detected Data Not Normal at 5% Significance Level

Lilliefors Test Statistic	0.253	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.181	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.012	Standard Error of Mean	0.00111
SD	0.00973	95% KM (BCA) UCL	0.014
95% KM (t) UCL	0.0138	95% KM (Percentile Bootstrap) UCL	0.0139
95% KM (z) UCL	0.0138	95% KM Bootstrap t UCL	0.0143
90% KM Chebyshev UCL	0.0153	95% KM Chebyshev UCL	0.0168
97.5% KM Chebyshev UCL	0.0189	99% KM Chebyshev UCL	0.023

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.332	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.753	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.225	**Kolmogrov-Smirnoff GOF**	
5% K-S Critical Value	0.18	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.475	k star (bias corrected MLE)	2.193
Theta hat (MLE)	0.00809	Theta star (bias corrected MLE)	0.00913
nu hat (MLE)	118.8	nu star (bias corrected)	105.3
MLE Mean (bias corrected)	0.02	MLE Sd (bias corrected)	0.0135

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	1.52	nu hat (KM)	258.4
Approximate Chi Square Value (258.43, α)	222.2	Adjusted Chi Square Value (258.43, β)	221.6
95% Gamma Approximate KM-UCL (use when n>=50)	0.0139	95% Gamma Adjusted KM-UCL (use when n<50)	0.014

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.00761	Mean	0.013
Maximum	0.0687	Median	0.01
SD	0.00932	CV	0.718
k hat (MLE)	4.597	k star (bias corrected MLE)	4.442
Theta hat (MLE)	0.00282	Theta star (bias corrected MLE)	0.00292
nu hat (MLE)	781.5	nu star (bias corrected)	755.2
MLE Mean (bias corrected)	0.013	MLE Sd (bias corrected)	0.00616
		Adjusted Level of Significance (β)	0.0472
Approximate Chi Square Value (755.22, α)	692.5	Adjusted Chi Square Value (755.22, β)	691.4
95% Gamma Approximate UCL (use when n>=50)	0.0142	95% Gamma Adjusted UCL (use when n<50)	0.0142

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.899	**Shapiro Wilk GOF Test**	

5% Shapiro Wilk Critical Value	0.916	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.204	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.181	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0105	Mean in Log Scale	-4.794
SD in Original Scale	0.0104	SD in Log Scale	0.617
95% t UCL (assumes normality of ROS data)	0.0124	95% Percentile Bootstrap UCL	0.0125
95% BCA Bootstrap UCL	0.0126	95% Bootstrap t UCL	0.0133
95% H-UCL (Log ROS)	0.0114		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0113	Mean in Log Scale	-4.694
SD in Original Scale	0.0102	SD in Log Scale	0.574
95% t UCL (Assumes normality)	0.0131	95% H-Stat UCL	0.0121

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.0138	95% KM (% Bootstrap) UCL	0.0139

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Molybdenum

General Statistics

Total Number of Observations	86	Number of Distinct Observations	79
		Number of Missing Observations	57
Number of Detects	81	Number of Non-Detects	5
Number of Distinct Detects	76	Number of Distinct Non-Detects	3
Minimum Detect	1.53	Minimum Non-Detect	1.46
Maximum Detect	125	Maximum Non-Detect	1.5
Variance Detects	505.9	Percent Non-Detects	5.814%
Mean Detects	16.54	SD Detects	22.49
Median Detects	8.72	CV Detects	1.36
Skewness Detects	3.024	Kurtosis Detects	9.98
Mean of Logged Detects	2.278	SD of Logged Detects	0.966

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.605	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level

Lilliefors Test Statistic	0.286	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0984	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	15.67	Standard Error of Mean	2.385
SD	21.98	95% KM (BCA) UCL	19.87
95% KM (t) UCL	19.63	95% KM (Percentile Bootstrap) UCL	19.92
95% KM (z) UCL	19.59	95% KM Bootstrap t UCL	20.86
90% KM Chebyshev UCL	22.82	95% KM Chebyshev UCL	26.06
97.5% KM Chebyshev UCL	30.56	99% KM Chebyshev UCL	39.39

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	3.361	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.78	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.185	**Kolmogrov-Smirnoff GOF**	
5% K-S Critical Value	0.102	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.084	k star (bias corrected MLE)	1.052
Theta hat (MLE)	15.26	Theta star (bias corrected MLE)	15.72
nu hat (MLE)	175.6	nu star (bias corrected)	170.4
MLE Mean (bias corrected)	16.54	MLE Sd (bias corrected)	16.13

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.508	nu hat (KM)	87.37
Approximate Chi Square Value (87.37, α)	66.82	Adjusted Chi Square Value (87.37, β)	66.52
95% Gamma Approximate KM-UCL (use when n>=50)	20.48	95% Gamma Adjusted KM-UCL (use when n<50)	20.58

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	15.58
Maximum	125	Median	8.405
SD	22.17	CV	1.423
k hat (MLE)	0.697	k star (bias corrected MLE)	0.68
Theta hat (MLE)	22.36	Theta star (bias corrected MLE)	22.91
nu hat (MLE)	119.8	nu star (bias corrected)	117
MLE Mean (bias corrected)	15.58	MLE Sd (bias corrected)	18.89
		Adjusted Level of Significance (β)	0.0472
Approximate Chi Square Value (116.99, α)	93.02	Adjusted Chi Square Value (116.99, β)	92.66
95% Gamma Approximate UCL (use when n>=50)	19.6	95% Gamma Adjusted UCL (use when n<50)	19.67

Lognormal GOF Test on Detected Observations Only

Lilliefors Test Statistic	0.103	**Lilliefors GOF Test**	

5% Lilliefors Critical Value	0.0984	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	15.64	Mean in Log Scale	2.148
SD in Original Scale	22.12	SD in Log Scale	1.076
95% t UCL (assumes normality of ROS data)	19.61	95% Percentile Bootstrap UCL	19.81
95% BCA Bootstrap UCL	20.65	95% Bootstrap t UCL	20.92
95% H-UCL (Log ROS)	20.02		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	15.62	Mean in Log Scale	2.129
SD in Original Scale	22.14	SD in Log Scale	1.116
95% t UCL (Assumes normality)	19.59	95% H-Stat UCL	20.81

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (BCA) UCL	19.87

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel

General Statistics

Total Number of Observations	85	Number of Distinct Observations	78
		Number of Missing Observations	58
Number of Detects	83	Number of Non-Detects	2
Number of Distinct Detects	77	Number of Distinct Non-Detects	1
Minimum Detect	0.705	Minimum Non-Detect	0.986
Maximum Detect	17.4	Maximum Non-Detect	0.986
Variance Detects	7.888	Percent Non-Detects	2.353%
Mean Detects	4.136	SD Detects	2.809
Median Detects	3.61	CV Detects	0.679
Skewness Detects	2.486	Kurtosis Detects	8.56
Mean of Logged Detects	1.246	SD of Logged Detects	0.584

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.786	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.172	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0973	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	4.055	Standard Error of Mean	0.306
SD	2.807	95% KM (BCA) UCL	4.536
95% KM (t) UCL	4.564	95% KM (Percentile Bootstrap) UCL	4.608
95% KM (z) UCL	4.559	95% KM Bootstrap t UCL	4.706
90% KM Chebyshev UCL	4.974	95% KM Chebyshev UCL	5.39
97.5% KM Chebyshev UCL	5.968	99% KM Chebyshev UCL	7.103

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.746	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.759	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0897	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.0988	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.037	k star (bias corrected MLE)	2.936
Theta hat (MLE)	1.362	Theta star (bias corrected MLE)	1.409
nu hat (MLE)	504.2	nu star (bias corrected)	487.3
MLE Mean (bias corrected)	4.136	MLE Sd (bias corrected)	2.414

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	2.087	nu hat (KM)	354.7
Approximate Chi Square Value (354.72, α)	312.1	Adjusted Chi Square Value (354.72, β)	311.4
95% Gamma Approximate KM-UCL (use when n>=50)	4.609	95% Gamma Adjusted KM-UCL (use when n<50)	4.619

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	4.04
Maximum	17.4	Median	3.61
SD	2.843	CV	0.704
k hat (MLE)	2.094	k star (bias corrected MLE)	2.028
Theta hat (MLE)	1.929	Theta star (bias corrected MLE)	1.992
nu hat (MLE)	356	nu star (bias corrected)	344.7
MLE Mean (bias corrected)	4.04	MLE Sd (bias corrected)	2.837
		Adjusted Level of Significance (β)	0.0472
Approximate Chi Square Value (344.73, α)	302.7	Adjusted Chi Square Value (344.73, β)	302
95% Gamma Approximate UCL (use when n>=50)	4.601	95% Gamma Adjusted UCL (use when n<50)	4.611

Lognormal GOF Test on Detected Observations Only

Lilliefors Test Statistic	0.0567	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0973	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	4.059	Mean in Log Scale	1.214
SD in Original Scale	2.819	SD in Log Scale	0.614
95% t UCL (assumes normality of ROS data)	4.568	95% Percentile Bootstrap UCL	4.575
95% BCA Bootstrap UCL	4.646	95% Bootstrap t UCL	4.673
95% H-UCL (Log ROS)	4.623		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	1.209	95% H-UCL (KM -Log)	4.634
KM SD (logged)	0.623	95% Critical H Value (KM-Log)	1.928
KM Standard Error of Mean (logged)	0.0679		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	4.05	Mean in Log Scale	1.2
SD in Original Scale	2.83	SD in Log Scale	0.649
95% t UCL (Assumes normality)	4.561	95% H-Stat UCL	4.709

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (BCA) UCL	4.536	95% GROS Approximate Gamma UCL	4.601
95% Approximate Gamma KM-UCL	4.609		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Selenium

General Statistics

Total Number of Observations	143	Number of Distinct Observations	96
Number of Detects	96	Number of Non-Detects	47
Number of Distinct Detects	95	Number of Distinct Non-Detects	2
Minimum Detect	0.451	Minimum Non-Detect	0.5
Maximum Detect	146	Maximum Non-Detect	0.6
Variance Detects	755.3	Percent Non-Detects	32.87%
Mean Detects	11.59	SD Detects	27.48
Median Detects	2.45	CV Detects	2.372
Skewness Detects	3.654	Kurtosis Detects	13.74
Mean of Logged Detects	1.154	SD of Logged Detects	1.392

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.436	**Normal GOF Test on Detected Observations Only**

5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.387	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0904	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	7.93	Standard Error of Mean	1.934
SD	23	95% KM (BCA) UCL	11.05
95% KM (t) UCL	11.13	95% KM (Percentile Bootstrap) UCL	11.1
95% KM (z) UCL	11.11	95% KM Bootstrap t UCL	12.39
90% KM Chebyshev UCL	13.73	95% KM Chebyshev UCL	16.36
97.5% KM Chebyshev UCL	20.01	99% KM Chebyshev UCL	27.17

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	9.498	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.821	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.24	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.0967	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.491	k star (bias corrected MLE)	0.483
Theta hat (MLE)	23.58	Theta star (bias corrected MLE)	23.99
nu hat (MLE)	94.35	nu star (bias corrected)	92.74
MLE Mean (bias corrected)	11.59	MLE Sd (bias corrected)	16.67

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.119	nu hat (KM)	33.99
Approximate Chi Square Value (33.99, α)	21.66	Adjusted Chi Square Value (33.99, β)	21.56
95% Gamma Approximate KM-UCL (use when n>=50)	12.45	95% Gamma Adjusted KM-UCL (use when n<50)	12.5

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	7.781
Maximum	146	Median	1.21
SD	23.13	CV	2.973
k hat (MLE)	0.254	k star (bias corrected MLE)	0.253
Theta hat (MLE)	30.65	Theta star (bias corrected MLE)	30.73
nu hat (MLE)	72.61	nu star (bias corrected)	72.42
MLE Mean (bias corrected)	7.781	MLE Sd (bias corrected)	15.46
		Adjusted Level of Significance (β)	0.0483
Approximate Chi Square Value (72.42, α)	53.83	Adjusted Chi Square Value (72.42, β)	53.66
95% Gamma Approximate UCL (use when n>=50)	10.47	95% Gamma Adjusted UCL (use when n<50)	10.5

Lognormal GOF Test on Detected Observations Only

Lilliefors Test Statistic	0.102	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0904	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	7.843	Mean in Log Scale	0.127
SD in Original Scale	23.11	SD in Log Scale	1.942
95% t UCL (assumes normality of ROS data)	11.04	95% Percentile Bootstrap UCL	11.19
95% BCA Bootstrap UCL	12.3	95% Bootstrap t UCL	12.27
95% H-UCL (Log ROS)	12.65		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	7.86	Mean in Log Scale	0.32
SD in Original Scale	23.11	SD in Log Scale	1.651
95% t UCL (Assumes normality)	11.06	95% H-Stat UCL	8.013

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 16.36

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Silver

General Statistics

Total Number of Observations	85	Number of Distinct Observations	38
		Number of Missing Observations	58
Number of Detects	5	Number of Non-Detects	80
Number of Distinct Detects	5	Number of Distinct Non-Detects	33
Minimum Detect	0.0546	Minimum Non-Detect	0.0459
Maximum Detect	0.164	Maximum Non-Detect	0.089
Variance Detects	0.00171	Percent Non-Detects	94.12%
Mean Detects	0.0937	SD Detects	0.0414
Median Detects	0.0835	CV Detects	0.442
Skewness Detects	1.666	Kurtosis Detects	3.458
Mean of Logged Detects	-2.435	SD of Logged Detects	0.397

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.824	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.354	**Lilliefors GOF Test**	

5% Lilliefors Critical Value	0.396	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.0487	Standard Error of Mean	0.00175
SD	0.0144	95% KM (BCA) UCL	0.0525
95% KM (t) UCL	0.0516	95% KM (Percentile Bootstrap) UCL	0.0518
95% KM (z) UCL	0.0516	95% KM Bootstrap t UCL	0.0516
90% KM Chebyshev UCL	0.054	95% KM Chebyshev UCL	0.0564
97.5% KM Chebyshev UCL	0.0597	99% KM Chebyshev UCL	0.0661

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.45	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.68	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.318	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	7.583	k star (bias corrected MLE)	3.166
Theta hat (MLE)	0.0124	Theta star (bias corrected MLE)	0.0296
nu hat (MLE)	75.83	nu star (bias corrected)	31.66
MLE Mean (bias corrected)	0.0937	MLE Sd (bias corrected)	0.0526

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	11.45	nu hat (KM)	1946
Approximate Chi Square Value (N/A, α)	1844	Adjusted Chi Square Value (N/A, β)	1843
95% Gamma Approximate KM-UCL (use when n>=50)	0.0514	95% Gamma Adjusted KM-UCL (use when n<50)	0.0515

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0149
Maximum	0.164	Median	0.01
SD	0.0218	CV	1.459
k hat (MLE)	1.984	k star (bias corrected MLE)	1.922
Theta hat (MLE)	0.00752	Theta star (bias corrected MLE)	0.00776
nu hat (MLE)	337.4	nu star (bias corrected)	326.8
MLE Mean (bias corrected)	0.0149	MLE Sd (bias corrected)	0.0108
		Adjusted Level of Significance (β)	0.0472
Approximate Chi Square Value (326.79, α)	285.9	Adjusted Chi Square Value (326.79, β)	285.2
95% Gamma Approximate UCL (use when n>=50)	0.0171	95% Gamma Adjusted UCL (use when n<50)	0.0171

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.913	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Lognormal at 5% Significance Level

Lilliefors Test Statistic	0.294	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.396	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0152	Mean in Log Scale	-4.602
SD in Original Scale	0.0225	SD in Log Scale	0.791
95% t UCL (assumes normality of ROS data)	0.0193	95% Percentile Bootstrap UCL	0.0193
95% BCA Bootstrap UCL	0.0208	95% Bootstrap t UCL	0.0223
95% H-UCL (Log ROS)	0.0164		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-3.043	95% H-UCL (KM -Log)	0.05
KM SD (logged)	0.175	95% Critical H Value (KM-Log)	1.696
KM Standard Error of Mean (logged)	0.0213		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0287	Mean in Log Scale	-3.631
SD in Original Scale	0.0188	SD in Log Scale	0.32
95% t UCL (Assumes normality)	0.0321	95% H-Stat UCL	0.0296

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.0516	95% KM (Percentile Bootstrap) UCL	0.0518

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Thallium

General Statistics

Total Number of Observations	85	Number of Distinct Observations	76
		Number of Missing Observations	58
Number of Detects	79	Number of Non-Detects	6
Number of Distinct Detects	72	Number of Distinct Non-Detects	4
Minimum Detect	0.013	Minimum Non-Detect	0.00978
Maximum Detect	0.713	Maximum Non-Detect	0.01
Variance Detects	0.0177	Percent Non-Detects	7.059%
Mean Detects	0.187	SD Detects	0.133
Median Detects	0.161	CV Detects	0.712
Skewness Detects	1.599	Kurtosis Detects	3.78
Mean of Logged Detects	-1.949	SD of Logged Detects	0.815

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.878	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	1.1429E-8	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.136	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0997	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.174	Standard Error of Mean	0.0148
SD	0.135	95% KM (BCA) UCL	0.2
95% KM (t) UCL	0.199	95% KM (Percentile Bootstrap) UCL	0.2
95% KM (z) UCL	0.199	95% KM Bootstrap t UCL	0.201
90% KM Chebyshev UCL	0.219	95% KM Chebyshev UCL	0.239
97.5% KM Chebyshev UCL	0.267	99% KM Chebyshev UCL	0.321

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.439	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.763	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.0958	**Kolmogrov-Smirnoff GOF**	
5% K-S Critical Value	0.102	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.995	k star (bias corrected MLE)	1.928
Theta hat (MLE)	0.0937	Theta star (bias corrected MLE)	0.0969
nu hat (MLE)	315.2	nu star (bias corrected)	304.6
MLE Mean (bias corrected)	0.187	MLE Sd (bias corrected)	0.135

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	1.663	nu hat (KM)	282.7
Approximate Chi Square Value (282.69, α)	244.8	Adjusted Chi Square Value (282.69, β)	244.1
95% Gamma Approximate KM-UCL (use when n>=50)	0.201	95% Gamma Adjusted KM-UCL (use when n<50)	0.202

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.174
Maximum	0.713	Median	0.153
SD	0.136	CV	0.78
k hat (MLE)	1.431	k star (bias corrected MLE)	1.389
Theta hat (MLE)	0.122	Theta star (bias corrected MLE)	0.126
nu hat (MLE)	243.3	nu star (bias corrected)	236.1
MLE Mean (bias corrected)	0.174	MLE Sd (bias corrected)	0.148
		Adjusted Level of Significance (β)	0.0472
Approximate Chi Square Value (236.07, α)	201.5	Adjusted Chi Square Value (236.07, β)	201

95% Gamma Approximate UCL (use when n>=50)	0.204	95% Gamma Adjusted UCL (use when n<50)	0.205

Lognormal GOF Test on Detected Observations Only

Lilliefors Test Statistic	0.143	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0997	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.175	Mean in Log Scale	-2.075
SD in Original Scale	0.135	SD in Log Scale	0.912
95% t UCL (assumes normality of ROS data)	0.2	95% Percentile Bootstrap UCL	0.199
95% BCA Bootstrap UCL	0.202	95% Bootstrap t UCL	0.201
95% H-UCL (Log ROS)	0.236		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.174	Mean in Log Scale	-2.186
SD in Original Scale	0.136	SD in Log Scale	1.169
95% t UCL (Assumes normality)	0.199	95% H-Stat UCL	0.303

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.239	95% GROS Approximate Gamma UCL	0.204
95% Approximate Gamma KM-UCL	0.201		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Uranium

General Statistics

Total Number of Observations	85	Number of Distinct Observations	38
		Number of Missing Observations	58
Number of Detects	7	Number of Non-Detects	78
Number of Distinct Detects	7	Number of Distinct Non-Detects	31
Minimum Detect	0.157	Minimum Non-Detect	0.0917
Maximum Detect	1.27	Maximum Non-Detect	0.178
Variance Detects	0.162	Percent Non-Detects	91.76%
Mean Detects	0.373	SD Detects	0.402
Median Detects	0.207	CV Detects	1.077
Skewness Detects	2.472	Kurtosis Detects	6.261
Mean of Logged Detects	-1.29	SD of Logged Detects	0.739

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.607	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.803	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.375	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.335	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.115	Standard Error of Mean	0.0155
SD	0.132	95% KM (BCA) UCL	0.143
95% KM (t) UCL	0.141	95% KM (Percentile Bootstrap) UCL	0.142
95% KM (z) UCL	0.14	95% KM Bootstrap t UCL	0.188
90% KM Chebyshev UCL	0.161	95% KM Chebyshev UCL	0.182
97.5% KM Chebyshev UCL	0.211	99% KM Chebyshev UCL	0.269

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.932	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.718	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.283	**Kolmogrov-Smirnoff GOF**	
5% K-S Critical Value	0.316	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.789	k star (bias corrected MLE)	1.118
Theta hat (MLE)	0.209	Theta star (bias corrected MLE)	0.334
nu hat (MLE)	25.05	nu star (bias corrected)	15.65
MLE Mean (bias corrected)	0.373	MLE Sd (bias corrected)	0.353

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.759	nu hat (KM)	129
Approximate Chi Square Value (129.00, α)	103.8	Adjusted Chi Square Value (129.00, β)	103.4
95% Gamma Approximate KM-UCL (use when n>=50)	0.143	95% Gamma Adjusted KM-UCL (use when n<50)	0.143

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0399
Maximum	1.27	Median	0.01
SD	0.147	CV	3.685
k hat (MLE)	0.562	k star (bias corrected MLE)	0.55
Theta hat (MLE)	0.0711	Theta star (bias corrected MLE)	0.0726
nu hat (MLE)	95.46	nu star (bias corrected)	93.43
MLE Mean (bias corrected)	0.0399	MLE Sd (bias corrected)	0.0538
		Adjusted Level of Significance (β)	0.0472
Approximate Chi Square Value (93.43, α)	72.14	Adjusted Chi Square Value (93.43, β)	71.81
95% Gamma Approximate UCL (use when n>=50)	0.0517	95% Gamma Adjusted UCL (use when n<50)	0.0519

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.786	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.803	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.224	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.335	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0378	Mean in Log Scale	-5.054
SD in Original Scale	0.148	SD in Log Scale	1.554
95% t UCL (assumes normality of ROS data)	0.0645	95% Percentile Bootstrap UCL	0.0648
95% BCA Bootstrap UCL	0.0879	95% Bootstrap t UCL	0.113
95% H-UCL (Log ROS)	0.0345		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-2.298	95% H-UCL (KM -Log)	0.115
KM SD (logged)	0.36	95% Critical H Value (KM-Log)	1.769
KM Standard Error of Mean (logged)	0.0423		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.076	Mean in Log Scale	-2.87
SD in Original Scale	0.14	SD in Log Scale	0.52
95% t UCL (Assumes normality)	0.101	95% H-Stat UCL	0.0721

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.141	95% GROS Approximate Gamma UCL	0.0517
95% Approximate Gamma KM-UCL	0.143		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Vanadium

General Statistics

Total Number of Observations	85	Number of Distinct Observations	80
		Number of Missing Observations	58
Number of Detects	82	Number of Non-Detects	3
Number of Distinct Detects	78	Number of Distinct Non-Detects	2
Minimum Detect	0.269	Minimum Non-Detect	0.616
Maximum Detect	13.1	Maximum Non-Detect	0.618

Variance Detects	2.127	Percent Non-Detects	3.529%
Mean Detects	0.931	SD Detects	1.458
Median Detects	0.628	CV Detects	1.567
Skewness Detects	7.417	Kurtosis Detects	61.44
Mean of Logged Detects	-0.372	SD of Logged Detects	0.629

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.354	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.325	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0978	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.914	Standard Error of Mean	0.156
SD	1.427	95% KM (BCA) UCL	1.241
95% KM (t) UCL	1.173	95% KM (Percentile Bootstrap) UCL	1.194
95% KM (z) UCL	1.17	95% KM Bootstrap t UCL	1.568
90% KM Chebyshev UCL	1.381	95% KM Chebyshev UCL	1.592
97.5% KM Chebyshev UCL	1.886	99% KM Chebyshev UCL	2.463

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	4.762	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.766	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.18	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.1	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.814	k star (bias corrected MLE)	1.756
Theta hat (MLE)	0.513	Theta star (bias corrected MLE)	0.53
nu hat (MLE)	297.5	nu star (bias corrected)	287.9
MLE Mean (bias corrected)	0.931	MLE Sd (bias corrected)	0.702

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.41	nu hat (KM)	69.71
Approximate Chi Square Value (69.71, α)	51.49	Adjusted Chi Square Value (69.71, β)	51.22
95% Gamma Approximate KM-UCL (use when n>=50)	1.237	95% Gamma Adjusted KM-UCL (use when n<50)	1.243

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0147	Mean	0.904
Maximum	13.1	Median	0.595
SD	1.439	CV	1.592
k hat (MLE)	1.613	k star (bias corrected MLE)	1.564

Theta hat (MLE)	0.561	Theta star (bias corrected MLE)	0.578
nu hat (MLE)	274.1	nu star (bias corrected)	265.8
MLE Mean (bias corrected)	0.904	MLE Sd (bias corrected)	0.723
		Adjusted Level of Significance (β)	0.0472
Approximate Chi Square Value (265.80, α)	229	Adjusted Chi Square Value (265.80, β)	228.5
95% Gamma Approximate UCL (use when n>=50)	1.049	95% Gamma Adjusted UCL (use when n<50)	1.052

Lognormal GOF Test on Detected Observations Only

Lilliefors Test Statistic	0.1	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0978	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.914	Mean in Log Scale	-0.388
SD in Original Scale	1.435	SD in Log Scale	0.623
95% t UCL (assumes normality of ROS data)	1.173	95% Percentile Bootstrap UCL	1.215
95% BCA Bootstrap UCL	1.402	95% Bootstrap t UCL	1.581
95% H-UCL (Log ROS)	0.94		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.909	Mean in Log Scale	-0.401
SD in Original Scale	1.437	SD in Log Scale	0.635
95% t UCL (Assumes normality)	1.168	95% H-Stat UCL	0.938

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (BCA) UCL 1.241

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zinc

General Statistics

Total Number of Observations	86	Number of Distinct Observations	79
		Number of Missing Observations	57
Minimum	12.8	Mean	51.71
Maximum	231	Median	47.3
SD	26.8	Std. Error of Mean	2.889
Coefficient of Variation	0.518	Skewness	3.668

Normal GOF Test

Shapiro Wilk Test Statistic	0.76	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.12	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0955	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	56.51	95% Adjusted-CLT UCL (Chen-1995)	57.68
		95% Modified-t UCL (Johnson-1978)	56.7

Gamma GOF Test

A-D Test Statistic	0.579	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.754	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.0648	**Kolmogrov-Smirnoff Gamma GOF Test**	
5% K-S Critical Value	0.0966	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.347	k star (bias corrected MLE)	5.169
Theta hat (MLE)	9.67	Theta star (bias corrected MLE)	10
nu hat (MLE)	919.7	nu star (bias corrected)	889
MLE Mean (bias corrected)	51.71	MLE Sd (bias corrected)	22.74
		Approximate Chi Square Value (0.05)	820.8
Adjusted Level of Significance	0.0472	Adjusted Chi Square Value	819.7

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	56	95% Adjusted Gamma UCL (use when n<50)	56.08

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.981	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.631	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0615	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0955	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.549	Mean of logged Data	3.849
Maximum of Logged Data	5.442	SD of logged Data	0.435

Assuming Lognormal Distribution

95% H-UCL	56.19	90% Chebyshev (MVUE) UCL	59.09
95% Chebyshev (MVUE) UCL	62.51	97.5% Chebyshev (MVUE) UCL	67.25
99% Chebyshev (MVUE) UCL	76.57		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	56.46	95% Jackknife UCL	56.51
95% Standard Bootstrap UCL	56.35	95% Bootstrap-t UCL	58.34
95% Hall's Bootstrap UCL	61.84	95% Percentile Bootstrap UCL	56.9
95% BCA Bootstrap UCL	57.7		
90% Chebyshev(Mean, Sd) UCL	60.38	95% Chebyshev(Mean, Sd) UCL	64.3
97.5% Chebyshev(Mean, Sd) UCL	69.75	99% Chebyshev(Mean, Sd) UCL	80.46

Suggested UCL to Use

95% Approximate Gamma UCL	56

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Henry Site Riparian Soil

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	6/19/2015 12:41:29 PM
From File	ProUCLinput-RSO.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Antimony

General Statistics

Total Number of Observations	6	Number of Distinct Observations	6
Number of Detects	5	Number of Non-Detects	1
Number of Distinct Detects	5	Number of Distinct Non-Detects	1
Minimum Detect	4.5	Minimum Non-Detect	3
Maximum Detect	7	Maximum Non-Detect	3
Variance Detects	1.043	Percent Non-Detects	16.67%
Mean Detects	5.44	SD Detects	1.021
Median Detects	5.3	CV Detects	0.188
Skewness Detects	0.945	Kurtosis Detects	0.294
Mean of Logged Detects	1.68	SD of Logged Detects	0.181

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.912	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.195	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.396	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	5.033	Standard Error of Mean	0.563
SD	1.234	95% KM (BCA) UCL	5.817
95% KM (t) UCL	6.168	95% KM (Percentile Bootstrap) UCL	5.833
95% KM (z) UCL	5.96	95% KM Bootstrap t UCL	5.897
90% KM Chebyshev UCL	6.723	95% KM Chebyshev UCL	7.488
97.5% KM Chebyshev UCL	8.55	99% KM Chebyshev UCL	10.64

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.298	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.678	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.227	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.357	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	37.32	k star (bias corrected MLE)	15.06
Theta hat (MLE)	0.146	Theta star (bias corrected MLE)	0.361
nu hat (MLE)	373.2	nu star (bias corrected)	150.6
MLE Mean (bias corrected)	5.44	MLE Sd (bias corrected)	1.402

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	16.64	nu hat (KM)	199.7
Approximate Chi Square Value (199.72, α)	168	Adjusted Chi Square Value (199.72, β)	157.5
95% Gamma Approximate KM-UCL (use when n>=50)	5.983	95% Gamma Adjusted KM-UCL (use when n<50)	6.383

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	3.026	Mean	5.038
Maximum	7	Median	4.95
SD	1.344	CV	0.267
k hat (MLE)	15.72	k star (bias corrected MLE)	7.971
Theta hat (MLE)	0.32	Theta star (bias corrected MLE)	0.632
nu hat (MLE)	188.6	nu star (bias corrected)	95.65
MLE Mean (bias corrected)	5.038	MLE Sd (bias corrected)	1.784
		Adjusted Level of Significance (β)	0.0122
Approximate Chi Square Value (95.65, α)	74.09	Adjusted Chi Square Value (95.65, β)	67.27
95% Gamma Approximate UCL (use when n>=50)	6.503	95% Gamma Adjusted UCL (use when n<50)	7.163

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.929	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.203	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.396	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	5.094	Mean in Log Scale	1.602
SD in Original Scale	1.247	SD in Log Scale	0.251
95% t UCL (assumes normality of ROS data)	6.119	95% Percentile Bootstrap UCL	5.833
95% BCA Bootstrap UCL	5.833	95% Bootstrap t UCL	6.324
95% H-UCL (Log ROS)	6.515		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	1.583	95% H-UCL (KM -Log)	6.5
KM SD (logged)	0.263	95% Critical H Value (KM-Log)	2.164
KM Standard Error of Mean (logged)	0.12		

DL/2 Statistics

DL/2 Normal	DL/2 Log-Transformed

Mean in Original Scale	4.783	Mean in Log Scale	1.468
SD in Original Scale	1.85	SD in Log Scale	0.545
95% t UCL (Assumes normality)	6.305	95% H-Stat UCL	9.841

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	6.168	95% KM (Percentile Bootstrap) UCL	5.833

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic

General Statistics

Total Number of Observations	6	Number of Distinct Observations	6
		Number of Missing Observations	0
Minimum	1.12	Mean	2.967
Maximum	4.99	Median	3.08
SD	1.563	Std. Error of Mean	0.638
Coefficient of Variation	0.527	Skewness	-0.041

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.935	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.19	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.362	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	4.252	95% Adjusted-CLT UCL (Chen-1995)	4.005
		95% Modified-t UCL (Johnson-1978)	4.25

Gamma GOF Test

A-D Test Statistic	0.352	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.7	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.217	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.334	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.624	k star (bias corrected MLE)	1.923
Theta hat (MLE)	0.819	Theta star (bias corrected MLE)	1.543
nu hat (MLE)	43.49	nu star (bias corrected)	23.08
MLE Mean (bias corrected)	2.967	MLE Sd (bias corrected)	2.139
		Approximate Chi Square Value (0.05)	13.15
Adjusted Level of Significance	0.0122	Adjusted Chi Square Value	10.55

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	5.207	95% Adjusted Gamma UCL (use when n<50)	6.491

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.892	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.788	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.196	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.362	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.113	Mean of logged Data	0.943
Maximum of Logged Data	1.607	SD of logged Data	0.622

Assuming Lognormal Distribution

95% H-UCL	7.084	90% Chebyshev (MVUE) UCL	5.291
95% Chebyshev (MVUE) UCL	6.325	97.5% Chebyshev (MVUE) UCL	7.761
99% Chebyshev (MVUE) UCL	10.58		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	4.016	95% Jackknife UCL	4.252
95% Standard Bootstrap UCL	3.936	95% Bootstrap-t UCL	4.355
95% Hall's Bootstrap UCL	3.934	95% Percentile Bootstrap UCL	3.973
95% BCA Bootstrap UCL	3.847		
90% Chebyshev(Mean, Sd) UCL	4.88	95% Chebyshev(Mean, Sd) UCL	5.747
97.5% Chebyshev(Mean, Sd) UCL	6.95	99% Chebyshev(Mean, Sd) UCL	9.314

Suggested UCL to Use

95% Student's-t UCL	4.252

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Boron

General Statistics

Total Number of Observations	6	Number of Distinct Observations	6
		Number of Missing Observations	0
Minimum	3.5	Mean	5.083
Maximum	5.9	Median	5.3
SD	0.873	Std. Error of Mean	0.356
Coefficient of Variation	0.172	Skewness	-1.417

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.88	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.206	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.362	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	5.801	95% Adjusted-CLT UCL (Chen-1995)	5.449
		95% Modified-t UCL (Johnson-1978)	5.767

Gamma GOF Test

A-D Test Statistic	0.488	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.697	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.222	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.332	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	35.45	k star (bias corrected MLE)	17.84
Theta hat (MLE)	0.143	Theta star (bias corrected MLE)	0.285
nu hat (MLE)	425.4	nu star (bias corrected)	214.1
MLE Mean (bias corrected)	5.083	MLE Sd (bias corrected)	1.204
		Approximate Chi Square Value (0.05)	181.2
Adjusted Level of Significance	0.0122	Adjusted Chi Square Value	170.2

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	6.005	95% Adjusted Gamma UCL (use when n<50)	6.392

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.834	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.788	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.244	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.362	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.253	Mean of logged Data	1.612
Maximum of Logged Data	1.775	SD of logged Data	0.191

Assuming Lognormal Distribution

95% H-UCL	6.086	90% Chebyshev (MVUE) UCL	6.281
95% Chebyshev (MVUE) UCL	6.82	97.5% Chebyshev (MVUE) UCL	7.57
99% Chebyshev (MVUE) UCL	9.042		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	5.669	95% Jackknife UCL	5.801
95% Standard Bootstrap UCL	5.627	95% Bootstrap-t UCL	5.629
95% Hall's Bootstrap UCL	5.482	95% Percentile Bootstrap UCL	5.567
95% BCA Bootstrap UCL	5.483		
90% Chebyshev(Mean, Sd) UCL	6.152	95% Chebyshev(Mean, Sd) UCL	6.636
97.5% Chebyshev(Mean, Sd) UCL	7.308	99% Chebyshev(Mean, Sd) UCL	8.628

Suggested UCL to Use

95% Student's-t UCL	5.801

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Cadmium

General Statistics

Total Number of Observations	34	Number of Distinct Observations	32
		Number of Missing Observations	0
Minimum	0.392	Mean	5.344
Maximum	67.3	Median	1.715
SD	11.77	Std. Error of Mean	2.019
Coefficient of Variation	2.203	Skewness	4.756

Normal GOF Test

Shapiro Wilk Test Statistic	0.412	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.933	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.339	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.152	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	8.761	95% Adjusted-CLT UCL (Chen-1995)	10.42
		95% Modified-t UCL (Johnson-1978)	9.035

Gamma GOF Test

A-D Test Statistic	2.35	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.792	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.203	**Kolmogrov-Smirnoff Gamma GOF Test**	
5% K-S Critical Value	0.157	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.706	k star (bias corrected MLE)	0.663
Theta hat (MLE)	7.574	Theta star (bias corrected MLE)	8.061
nu hat (MLE)	47.98	nu star (bias corrected)	45.08
MLE Mean (bias corrected)	5.344	MLE Sd (bias corrected)	6.564
		Approximate Chi Square Value (0.05)	30.68
Adjusted Level of Significance	0.0422	Adjusted Chi Square Value	30.09

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	7.853	95% Adjusted Gamma UCL (use when n<50)	8.007

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.933	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.933	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.149	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.152	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.936	Mean of logged Data	0.82
Maximum of Logged Data	4.209	SD of logged Data	1.144

Assuming Lognormal Distribution

95% H-UCL	7.38	90% Chebyshev (MVUE) UCL	7.222
95% Chebyshev (MVUE) UCL	8.572	97.5% Chebyshev (MVUE) UCL	10.45
99% Chebyshev (MVUE) UCL	14.13		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	8.665	95% Jackknife UCL	8.761
95% Standard Bootstrap UCL	8.694	95% Bootstrap-t UCL	16.47
95% Hall's Bootstrap UCL	20.02	95% Percentile Bootstrap UCL	8.924
95% BCA Bootstrap UCL	11.09		
90% Chebyshev(Mean, Sd) UCL	11.4	95% Chebyshev(Mean, Sd) UCL	14.14
97.5% Chebyshev(Mean, Sd) UCL	17.95	99% Chebyshev(Mean, Sd) UCL	25.43

Suggested UCL to Use

95% H-UCL 7.38

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Chromium

General Statistics

Total Number of Observations	34	Number of Distinct Observations	32
		Number of Missing Observations	0
Minimum	14.4	Mean	55.93
Maximum	467	Median	28.45
SD	90.07	Std. Error of Mean	15.45
Coefficient of Variation	1.61	Skewness	3.762

Normal GOF Test

Shapiro Wilk Test Statistic	0.447	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.933	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.376	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.152	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	82.07	95% Adjusted-CLT UCL (Chen-1995)	91.98
		95% Modified-t UCL (Johnson-1978)	83.73

Gamma GOF Test

A-D Test Statistic	4.144	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.772	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.272	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.155	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.204	k star (bias corrected MLE)	1.117
Theta hat (MLE)	46.46	Theta star (bias corrected MLE)	50.06
nu hat (MLE)	81.86	nu star (bias corrected)	75.97
MLE Mean (bias corrected)	55.93	MLE Sd (bias corrected)	52.91
		Approximate Chi Square Value (0.05)	56.89
Adjusted Level of Significance	0.0422	Adjusted Chi Square Value	56.08

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	74.68	95% Adjusted Gamma UCL (use when n<50)	75.77

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.804	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.933	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.198	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.152	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.667	Mean of logged Data	3.554
Maximum of Logged Data	6.146	SD of logged Data	0.785

Assuming Lognormal Distribution

95% H-UCL	64.3	90% Chebyshev (MVUE) UCL	68
95% Chebyshev (MVUE) UCL	77.5	97.5% Chebyshev (MVUE) UCL	90.69
99% Chebyshev (MVUE) UCL	116.6		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	81.34	95% Jackknife UCL	82.07
95% Standard Bootstrap UCL	81.93	95% Bootstrap-t UCL	178.4
95% Hall's Bootstrap UCL	196.1	95% Percentile Bootstrap UCL	83.32
95% BCA Bootstrap UCL	95.47		
90% Chebyshev(Mean, Sd) UCL	102.3	95% Chebyshev(Mean, Sd) UCL	123.3
97.5% Chebyshev(Mean, Sd) UCL	152.4	99% Chebyshev(Mean, Sd) UCL	209.6

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	123.3

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Cobalt

General Statistics

Total Number of Observations	6	Number of Distinct Observations	6
		Number of Missing Observations	0
Minimum	4.25	Mean	6.44
Maximum	8.73	Median	6.745
SD	1.872	Std. Error of Mean	0.764
Coefficient of Variation	0.291	Skewness	-0.202

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.906	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.205	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.362	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	7.98	95% Adjusted-CLT UCL (Chen-1995)	7.629
		95% Modified-t UCL (Johnson-1978)	7.969

Gamma GOF Test

A-D Test Statistic	0.412	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.698	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.231	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.332	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	13.26	k star (bias corrected MLE)	6.743
Theta hat (MLE)	0.486	Theta star (bias corrected MLE)	0.955
nu hat (MLE)	159.2	nu star (bias corrected)	80.92
MLE Mean (bias corrected)	6.44	MLE Sd (bias corrected)	2.48
		Approximate Chi Square Value (0.05)	61.19
Adjusted Level of Significance	0.0122	Adjusted Chi Square Value	55.03

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	8.516	95% Adjusted Gamma UCL (use when n<50)	9.469

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.879	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.788	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.214	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.362	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.447	Mean of logged Data	1.824
Maximum of Logged Data	2.167	SD of logged Data	0.309

Assuming Lognormal Distribution

95% H-UCL	8.859	90% Chebyshev (MVUE) UCL	8.886
95% Chebyshev (MVUE) UCL	9.99	97.5% Chebyshev (MVUE) UCL	11.52
99% Chebyshev (MVUE) UCL	14.53		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	7.697	95% Jackknife UCL	7.98
95% Standard Bootstrap UCL	7.596	95% Bootstrap-t UCL	7.908
95% Hall's Bootstrap UCL	7.481	95% Percentile Bootstrap UCL	7.623
95% BCA Bootstrap UCL	7.537		
90% Chebyshev(Mean, Sd) UCL	8.732	95% Chebyshev(Mean, Sd) UCL	9.771
97.5% Chebyshev(Mean, Sd) UCL	11.21	99% Chebyshev(Mean, Sd) UCL	14.04

Suggested UCL to Use

95% Student's-t UCL	7.98

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Copper

General Statistics

Total Number of Observations	34	Number of Distinct Observations	32
		Number of Missing Observations	0
Minimum	5.8	Mean	18.98
Maximum	56	Median	16.9
SD	9.936	Std. Error of Mean	1.704
Coefficient of Variation	0.524	Skewness	2.106

Normal GOF Test

Shapiro Wilk Test Statistic	0.812	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.933	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.182	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.152	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	21.86	95% Adjusted-CLT UCL (Chen-1995)	22.44
		95% Modified-t UCL (Johnson-1978)	21.97

Gamma GOF Test

A-D Test Statistic	0.535	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.75	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.116	**Kolmogrov-Smirnoff Gamma GOF Test**	
5% K-S Critical Value	0.151	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.827	k star (bias corrected MLE)	4.421
Theta hat (MLE)	3.932	Theta star (bias corrected MLE)	4.293
nu hat (MLE)	328.2	nu star (bias corrected)	300.6
MLE Mean (bias corrected)	18.98	MLE Sd (bias corrected)	9.027
		Approximate Chi Square Value (0.05)	261.4
Adjusted Level of Significance	0.0422	Adjusted Chi Square Value	259.6

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	21.82	95% Adjusted Gamma UCL (use when n<50)	21.97

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.975	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.933	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.101	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.152	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.758	Mean of logged Data	2.836
Maximum of Logged Data	4.025	SD of logged Data	0.461

Assuming Lognormal Distribution

95% H-UCL	22.1	90% Chebyshev (MVUE) UCL	23.55
95% Chebyshev (MVUE) UCL	25.66	97.5% Chebyshev (MVUE) UCL	28.59
99% Chebyshev (MVUE) UCL	34.34		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	21.78	95% Jackknife UCL	21.86
95% Standard Bootstrap UCL	21.73	95% Bootstrap-t UCL	22.78
95% Hall's Bootstrap UCL	25.63	95% Percentile Bootstrap UCL	21.83
95% BCA Bootstrap UCL	22.69		

90% Chebyshev(Mean, Sd) UCL	24.09	95% Chebyshev(Mean, Sd) UCL	26.41
97.5% Chebyshev(Mean, Sd) UCL	29.62	99% Chebyshev(Mean, Sd) UCL	35.93

Suggested UCL to Use

95% Adjusted Gamma UCL	21.97

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Manganese

General Statistics

Total Number of Observations	6	Number of Distinct Observations	6
		Number of Missing Observations	0
Minimum	145	Mean	582.5
Maximum	1080	Median	599
SD	387.4	Std. Error of Mean	158.2
Coefficient of Variation	0.665	Skewness	-0.016

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.91	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.203	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.362	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	901.2	95% Adjusted-CLT UCL (Chen-1995)	841.6
		95% Modified-t UCL (Johnson-1978)	901.1

Gamma GOF Test

A-D Test Statistic	0.49	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.704	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.243	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.336	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.978	k star (bias corrected MLE)	1.1
Theta hat (MLE)	294.4	Theta star (bias corrected MLE)	529.4

nu hat (MLE)	23.74	nu star (bias corrected)	13.2
MLE Mean (bias corrected)	582.5	MLE Sd (bias corrected)	555.3
		Approximate Chi Square Value (0.05)	6.03
Adjusted Level of Significance	0.0122	Adjusted Chi Square Value	4.4

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1275	95% Adjusted Gamma UCL (use when n<50)	1748

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.827	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.788	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.272	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.362	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.977	Mean of logged Data	6.094
Maximum of Logged Data	6.985	SD of logged Data	0.895

Assuming Lognormal Distribution

95% H-UCL	2971	90% Chebyshev (MVUE) UCL	1270
95% Chebyshev (MVUE) UCL	1570	97.5% Chebyshev (MVUE) UCL	1985
99% Chebyshev (MVUE) UCL	2801		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	842.7	95% Jackknife UCL	901.2
95% Standard Bootstrap UCL	816.8	95% Bootstrap-t UCL	891.3
95% Hall's Bootstrap UCL	860.9	95% Percentile Bootstrap UCL	824.5
95% BCA Bootstrap UCL	798.8		
90% Chebyshev(Mean, Sd) UCL	1057	95% Chebyshev(Mean, Sd) UCL	1272
97.5% Chebyshev(Mean, Sd) UCL	1570	99% Chebyshev(Mean, Sd) UCL	2156

Suggested UCL to Use

95% Student's-t UCL	901.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Mercury

General Statistics

Total Number of Observations	6	Number of Distinct Observations	6
		Number of Missing Observations	0
Minimum	0.012	Mean	0.0195
Maximum	0.024	Median	0.0215
SD	0.00485	Std. Error of Mean	0.00198
Coefficient of Variation	0.249	Skewness	-0.948

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.86	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.288	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.362	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.0235	95% Adjusted-CLT UCL (Chen-1995)	0.0219
		95% Modified-t UCL (Johnson-1978)	0.0234

Gamma GOF Test

A-D Test Statistic	0.572	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.697	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.318	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.332	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	16.79	k star (bias corrected MLE)	8.508
Theta hat (MLE)	0.00116	Theta star (bias corrected MLE)	0.00229
nu hat (MLE)	201.5	nu star (bias corrected)	102.1
MLE Mean (bias corrected)	0.0195	MLE Sd (bias corrected)	0.00669
		Approximate Chi Square Value (0.05)	79.78
Adjusted Level of Significance	0.0122	Adjusted Chi Square Value	72.68

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.025	95% Adjusted Gamma UCL (use when n<50)	0.0274

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.833	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.788	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.312	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.362	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-4.423	Mean of logged Data	-3.967
Maximum of Logged Data	-3.73	SD of logged Data	0.279

Assuming Lognormal Distribution

95% H-UCL	0.0259	90% Chebyshev (MVUE) UCL	0.0262
95% Chebyshev (MVUE) UCL	0.0292	97.5% Chebyshev (MVUE) UCL	0.0334
99% Chebyshev (MVUE) UCL	0.0417		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.0228	95% Jackknife UCL	0.0235
95% Standard Bootstrap UCL	0.0225	95% Bootstrap-t UCL	0.0228
95% Hall's Bootstrap UCL	0.0216	95% Percentile Bootstrap UCL	0.0225
95% BCA Bootstrap UCL	0.0218		
90% Chebyshev(Mean, Sd) UCL	0.0254	95% Chebyshev(Mean, Sd) UCL	0.0281
97.5% Chebyshev(Mean, Sd) UCL	0.0319	99% Chebyshev(Mean, Sd) UCL	0.0392

Suggested UCL to Use

95% Student's-t UCL	0.0235

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Molybdenum

General Statistics

Total Number of Observations	34	Number of Distinct Observations	25
Number of Detects	27	Number of Non-Detects	7
Number of Distinct Detects	23	Number of Distinct Non-Detects	2
Minimum Detect	0.287	Minimum Non-Detect	0.05
Maximum Detect	14.8	Maximum Non-Detect	0.5
Variance Detects	9.668	Percent Non-Detects	20.59%
Mean Detects	1.921	SD Detects	3.109
Median Detects	0.59	CV Detects	1.619
Skewness Detects	3.21	Kurtosis Detects	11.56
Mean of Logged Detects	-0.0726	SD of Logged Detects	1.121

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.567	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.923	Detected Data Not Normal at 5% Significance Level

Lilliefors Test Statistic	0.3	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.171	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	1.585	Standard Error of Mean	0.489
SD	2.799	95% KM (BCA) UCL	2.506
95% KM (t) UCL	2.412	95% KM (Percentile Bootstrap) UCL	2.449
95% KM (z) UCL	2.389	95% KM Bootstrap t UCL	3.336
90% KM Chebyshev UCL	3.052	95% KM Chebyshev UCL	3.717
97.5% KM Chebyshev UCL	4.639	99% KM Chebyshev UCL	6.452

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.856	Anderson-Darling GOF Test	
5% A-D Critical Value	0.781	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.209	Kolmogrov-Smirnoff GOF	
5% K-S Critical Value	0.174	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.816	k star (bias corrected MLE)	0.75
Theta hat (MLE)	2.353	Theta star (bias corrected MLE)	2.56
nu hat (MLE)	44.07	nu star (bias corrected)	40.51
MLE Mean (bias corrected)	1.921	MLE Sd (bias corrected)	2.218

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.321	nu hat (KM)	21.8
Approximate Chi Square Value (21.80, α)	12.19	Adjusted Chi Square Value (21.80, β)	11.83
95% Gamma Approximate KM-UCL (use when n>=50)	2.834	95% Gamma Adjusted KM-UCL (use when n<50)	2.919

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	1.539
Maximum	14.8	Median	0.421
SD	2.863	CV	1.86
k hat (MLE)	0.481	k star (bias corrected MLE)	0.458
Theta hat (MLE)	3.198	Theta star (bias corrected MLE)	3.357
nu hat (MLE)	32.73	nu star (bias corrected)	31.17
MLE Mean (bias corrected)	1.539	MLE Sd (bias corrected)	2.273
		Adjusted Level of Significance (β)	0.0422
Approximate Chi Square Value (31.17, α)	19.42	Adjusted Chi Square Value (31.17, β)	18.96
95% Gamma Approximate UCL (use when n>=50)	2.471	95% Gamma Adjusted UCL (use when n<50)	2.531

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.875	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.923	Detected Data Not Lognormal at 5% Significance Level	

Lilliefors Test Statistic	0.199	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.171	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.592	Mean in Log Scale	-0.341
SD in Original Scale	2.838	SD in Log Scale	1.186
95% t UCL (assumes normality of ROS data)	2.416	95% Percentile Bootstrap UCL	2.433
95% BCA Bootstrap UCL	2.865	95% Bootstrap t UCL	3.413
95% H-UCL (Log ROS)	2.498		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.57	Mean in Log Scale	-0.411
SD in Original Scale	2.847	SD in Log Scale	1.258
95% t UCL (Assumes normality)	2.396	95% H-Stat UCL	2.69

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

97.5% KM (Chebyshev) UCL	4.639

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel

General Statistics

Total Number of Observations	34	Number of Distinct Observations	33
		Number of Missing Observations	0
Minimum	10.3	Mean	35.59
Maximum	251	Median	20.4
SD	46.54	Std. Error of Mean	7.982
Coefficient of Variation	1.308	Skewness	3.622

Normal GOF Test

Shapiro Wilk Test Statistic	0.543	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.933	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.293	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.152	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL	**95% UCLs (Adjusted for Skewness)**

95% Student's-t UCL	49.1	95% Adjusted-CLT UCL (Chen-1995)	54.01
		95% Modified-t UCL (Johnson-1978)	49.92

Gamma GOF Test

A-D Test Statistic	2.143	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.767	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.191	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.154	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.436	k star (bias corrected MLE)	1.329
Theta hat (MLE)	24.79	Theta star (bias corrected MLE)	26.78
nu hat (MLE)	97.64	nu star (bias corrected)	90.35
MLE Mean (bias corrected)	35.59	MLE Sd (bias corrected)	30.87
		Approximate Chi Square Value (0.05)	69.44
Adjusted Level of Significance	0.0422	Adjusted Chi Square Value	68.53

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	46.31	95% Adjusted Gamma UCL (use when n<50)	46.92

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.888	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.933	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.135	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.152	Data appear Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.332	Mean of logged Data	3.185
Maximum of Logged Data	5.525	SD of logged Data	0.775

Assuming Lognormal Distribution

95% H-UCL	43.85	90% Chebyshev (MVUE) UCL	46.42
95% Chebyshev (MVUE) UCL	52.84	97.5% Chebyshev (MVUE) UCL	61.75
99% Chebyshev (MVUE) UCL	79.24		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	48.72	95% Jackknife UCL	49.1
95% Standard Bootstrap UCL	48.27	95% Bootstrap-t UCL	66.69
95% Hall's Bootstrap UCL	105.8	95% Percentile Bootstrap UCL	50.34
95% BCA Bootstrap UCL	55.24		
90% Chebyshev(Mean, Sd) UCL	59.53	95% Chebyshev(Mean, Sd) UCL	70.38
97.5% Chebyshev(Mean, Sd) UCL	85.44	99% Chebyshev(Mean, Sd) UCL	115

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	70.38

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Selenium

General Statistics

Total Number of Observations	34	Number of Distinct Observations	21
Number of Detects	28	Number of Non-Detects	6
Number of Distinct Detects	20	Number of Distinct Non-Detects	1
Minimum Detect	0.7	Minimum Non-Detect	0.5
Maximum Detect	45	Maximum Non-Detect	0.5
Variance Detects	103.7	Percent Non-Detects	17.65%
Mean Detects	5.731	SD Detects	10.18
Median Detects	1.45	CV Detects	1.777
Skewness Detects	2.874	Kurtosis Detects	8.437
Mean of Logged Detects	0.872	SD of Logged Detects	1.183

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.545	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.924	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.311	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.167	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	4.808	Standard Error of Mean	1.623
SD	9.293	95% KM (BCA) UCL	7.83
95% KM (t) UCL	7.554	95% KM (Percentile Bootstrap) UCL	7.664
95% KM (z) UCL	7.477	95% KM Bootstrap t UCL	10.06
90% KM Chebyshev UCL	9.676	95% KM Chebyshev UCL	11.88
97.5% KM Chebyshev UCL	14.94	99% KM Chebyshev UCL	20.96

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.82	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.791	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.288	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.173	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.692	k star (bias corrected MLE)	0.642
Theta hat (MLE)	8.276	Theta star (bias corrected MLE)	8.925
nu hat (MLE)	38.78	nu star (bias corrected)	35.96
MLE Mean (bias corrected)	5.731	MLE Sd (bias corrected)	7.152

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.268	nu hat (KM)	18.2
Approximate Chi Square Value (18.20, α)	9.537	Adjusted Chi Square Value (18.20, β)	9.227
95% Gamma Approximate KM-UCL (use when n>=50)	9.176	95% Gamma Adjusted KM-UCL (use when n<50)	9.485

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	4.721
Maximum	45	Median	1.35
SD	9.475	CV	2.007
k hat (MLE)	0.4	k star (bias corrected MLE)	0.384
Theta hat (MLE)	11.81	Theta star (bias corrected MLE)	12.3
nu hat (MLE)	27.18	nu star (bias corrected)	26.11
MLE Mean (bias corrected)	4.721	MLE Sd (bias corrected)	7.619
		Adjusted Level of Significance (β)	0.0422
Approximate Chi Square Value (26.11, α)	15.47	Adjusted Chi Square Value (26.11, β)	15.06
95% Gamma Approximate UCL (use when n>=50)	7.971	95% Gamma Adjusted UCL (use when n<50)	8.186

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.844	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.924	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.232	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.167	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	4.752	Mean in Log Scale	0.4
SD in Original Scale	9.459	SD in Log Scale	1.502
95% t UCL (assumes normality of ROS data)	7.497	95% Percentile Bootstrap UCL	7.652
95% BCA Bootstrap UCL	8.626	95% Bootstrap t UCL	9.968
95% H-UCL (Log ROS)	10.43		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	4.764	Mean in Log Scale	0.473
SD in Original Scale	9.453	SD in Log Scale	1.381
95% t UCL (Assumes normality)	7.507	95% H-Stat UCL	8.468

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

97.5% KM (Chebyshev) UCL	14.94

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Thallium

General Statistics

Total Number of Observations	6	Number of Distinct Observations	6
		Number of Missing Observations	0
Minimum	0.105	Mean	0.162
Maximum	0.223	Median	0.166
SD	0.0471	Std. Error of Mean	0.0192
Coefficient of Variation	0.292	Skewness	-0.0895

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.927	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.196	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.362	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.2	95% Adjusted-CLT UCL (Chen-1995)	0.192
		95% Modified-t UCL (Johnson-1978)	0.2

Gamma GOF Test

A-D Test Statistic	0.36	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.698	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.222	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.332	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	13.3	k star (bias corrected MLE)	6.759
Theta hat (MLE)	0.0121	Theta star (bias corrected MLE)	0.0239
nu hat (MLE)	159.5	nu star (bias corrected)	81.11
MLE Mean (bias corrected)	0.162	MLE Sd (bias corrected)	0.0621
		Approximate Chi Square Value (0.05)	61.35
Adjusted Level of Significance	0.0122	Adjusted Chi Square Value	55.19

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.213	95% Adjusted Gamma UCL (use when n<50)	0.237

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.902	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.788	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.228	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.362	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-2.254	Mean of logged Data	-1.861
Maximum of Logged Data	-1.501	SD of logged Data	0.308

Assuming Lognormal Distribution

95% H-UCL	0.222	90% Chebyshev (MVUE) UCL	0.223
95% Chebyshev (MVUE) UCL	0.25	97.5% Chebyshev (MVUE) UCL	0.289
99% Chebyshev (MVUE) UCL	0.364		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.193	95% Jackknife UCL	0.2
95% Standard Bootstrap UCL	0.19	95% Bootstrap-t UCL	0.197
95% Hall's Bootstrap UCL	0.19	95% Percentile Bootstrap UCL	0.19
95% BCA Bootstrap UCL	0.19		
90% Chebyshev(Mean, Sd) UCL	0.219	95% Chebyshev(Mean, Sd) UCL	0.245
97.5% Chebyshev(Mean, Sd) UCL	0.282	99% Chebyshev(Mean, Sd) UCL	0.353

Suggested UCL to Use

95% Student's-t UCL	0.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Uranium

General Statistics

Total Number of Observations	6	Number of Distinct Observations	6
		Number of Missing Observations	0
Minimum	0.748	Mean	1.158
Maximum	1.66	Median	1.13
SD	0.334	Std. Error of Mean	0.136
Coefficient of Variation	0.289	Skewness	0.404

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.966	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.788	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.188	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.362	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1.433	95% Adjusted-CLT UCL (Chen-1995)	1.406
		95% Modified-t UCL (Johnson-1978)	1.436

Gamma GOF Test

A-D Test Statistic	0.204	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.698	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.155	**Kolmogrov-Smirnoff Gamma GOF Test**	
5% K-S Critical Value	0.332	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	14.37	k star (bias corrected MLE)	7.294
Theta hat (MLE)	0.0806	Theta star (bias corrected MLE)	0.159
nu hat (MLE)	172.4	nu star (bias corrected)	87.53
MLE Mean (bias corrected)	1.158	MLE Sd (bias corrected)	0.429
		Approximate Chi Square Value (0.05)	66.96
Adjusted Level of Significance	0.0122	Adjusted Chi Square Value	60.5

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.513	95% Adjusted Gamma UCL (use when n<50)	1.675

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.974	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.788	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.17	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.362	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.29	Mean of logged Data	0.111
Maximum of Logged Data	0.507	SD of logged Data	0.292

Assuming Lognormal Distribution

95% H-UCL	1.558	90% Chebyshev (MVUE) UCL	1.572

95% Chebyshev (MVUE) UCL	1.76	97.5% Chebyshev (MVUE) UCL	2.021
99% Chebyshev (MVUE) UCL	2.532		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.382	95% Jackknife UCL	1.433
95% Standard Bootstrap UCL	1.368	95% Bootstrap-t UCL	1.501
95% Hall's Bootstrap UCL	1.595	95% Percentile Bootstrap UCL	1.356
95% BCA Bootstrap UCL	1.375		
90% Chebyshev(Mean, Sd) UCL	1.567	95% Chebyshev(Mean, Sd) UCL	1.753
97.5% Chebyshev(Mean, Sd) UCL	2.01	99% Chebyshev(Mean, Sd) UCL	2.516

Suggested UCL to Use

95% Student's-t UCL 1.433

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Vanadium

General Statistics

Total Number of Observations	34	Number of Distinct Observations	34
		Number of Missing Observations	0
Minimum	14.7	Mean	67.21
Maximum	773	Median	33.85
SD	130.7	Std. Error of Mean	22.41
Coefficient of Variation	1.944	Skewness	5.109

Normal GOF Test

Shapiro Wilk Test Statistic	0.359	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.933	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.386	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.152	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	105.1	95% Adjusted-CLT UCL (Chen-1995)	125
		95% Modified-t UCL (Johnson-1978)	108.4

Gamma GOF Test

A-D Test Statistic	3.809	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.773	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.265	**Kolmogrov-Smirnoff Gamma GOF Test**

5% K-S Critical Value	0.155	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.142	k star (bias corrected MLE)	1.061
Theta hat (MLE)	58.84	Theta star (bias corrected MLE)	63.35
nu hat (MLE)	77.67	nu star (bias corrected)	72.15
MLE Mean (bias corrected)	67.21	MLE Sd (bias corrected)	65.25
		Approximate Chi Square Value (0.05)	53.59
Adjusted Level of Significance	0.0422	Adjusted Chi Square Value	52.8

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	90.49	95% Adjusted Gamma UCL (use when n<50)	91.84

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.83	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.933	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.15	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.152	Data appear Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.688	Mean of logged Data	3.71
Maximum of Logged Data	6.65	SD of logged Data	0.775

Assuming Lognormal Distribution

95% H-UCL	74.15	90% Chebyshev (MVUE) UCL	78.5
95% Chebyshev (MVUE) UCL	89.35	97.5% Chebyshev (MVUE) UCL	104.4
99% Chebyshev (MVUE) UCL	134		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	104.1	95% Jackknife UCL	105.1
95% Standard Bootstrap UCL	103	95% Bootstrap-t UCL	236.7
95% Hall's Bootstrap UCL	250.7	95% Percentile Bootstrap UCL	109.1
95% BCA Bootstrap UCL	133.2		
90% Chebyshev(Mean, Sd) UCL	134.4	95% Chebyshev(Mean, Sd) UCL	164.9
97.5% Chebyshev(Mean, Sd) UCL	207.1	99% Chebyshev(Mean, Sd) UCL	290.2

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	164.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Zinc

General Statistics

Total Number of Observations	34	Number of Distinct Observations	32
		Number of Missing Observations	0
Minimum	49.7	Mean	188.8
Maximum	1600	Median	111
SD	277.9	Std. Error of Mean	47.66
Coefficient of Variation	1.472	Skewness	4.322

Normal GOF Test

Shapiro Wilk Test Statistic	0.482	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.933	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.308	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.152	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	269.5	95% Adjusted-CLT UCL (Chen-1995)	304.9
		95% Modified-t UCL (Johnson-1978)	275.3

Gamma GOF Test

A-D Test Statistic	2.306	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.769	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.21	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.154	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.339	k star (bias corrected MLE)	1.241
Theta hat (MLE)	141	Theta star (bias corrected MLE)	152.2
nu hat (MLE)	91.08	nu star (bias corrected)	84.38
MLE Mean (bias corrected)	188.8	MLE Sd (bias corrected)	169.5
		Approximate Chi Square Value (0.05)	64.21
Adjusted Level of Significance	0.0422	Adjusted Chi Square Value	63.34

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	248.1	95% Adjusted Gamma UCL (use when n<50)	251.5

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.889	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.933	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.135	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.152	Data appear Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.906	Mean of logged Data	4.823
Maximum of Logged Data	7.378	SD of logged Data	0.785

Assuming Lognormal Distribution

95% H-UCL	228.9	90% Chebyshev (MVUE) UCL	242
95% Chebyshev (MVUE) UCL	275.8	97.5% Chebyshev (MVUE) UCL	322.8
99% Chebyshev (MVUE) UCL	415		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	267.2	95% Jackknife UCL	269.5
95% Standard Bootstrap UCL	267.2	95% Bootstrap-t UCL	387.8
95% Hall's Bootstrap UCL	537.5	95% Percentile Bootstrap UCL	274.2
95% BCA Bootstrap UCL	330.8		
90% Chebyshev(Mean, Sd) UCL	331.8	95% Chebyshev(Mean, Sd) UCL	396.5
97.5% Chebyshev(Mean, Sd) UCL	486.4	99% Chebyshev(Mean, Sd) UCL	663

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	396.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Henry Site Riparian Vegetation

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	6/19/2015 12:42:57 PM
From File	ProUCLinput-RVEG.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Cadmium

General Statistics

Total Number of Observations	28	Number of Distinct Observations	21
Number of Detects	21	Number of Non-Detects	7
Number of Distinct Detects	21	Number of Distinct Non-Detects	1
Minimum Detect	0.05	Minimum Non-Detect	0.05
Maximum Detect	2.87	Maximum Non-Detect	0.05
Variance Detects	0.491	Percent Non-Detects	25%
Mean Detects	0.626	SD Detects	0.701
Median Detects	0.41	CV Detects	1.12
Skewness Detects	2.397	Kurtosis Detects	5.766
Mean of Logged Detects	-0.927	SD of Logged Detects	0.998

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.688	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.908	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.263	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.193	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.482	Standard Error of Mean	0.124
SD	0.643	95% KM (BCA) UCL	0.713
95% KM (t) UCL	0.694	95% KM (Percentile Bootstrap) UCL	0.692
95% KM (z) UCL	0.686	95% KM Bootstrap t UCL	0.895
90% KM Chebyshev UCL	0.855	95% KM Chebyshev UCL	1.024
97.5% KM Chebyshev UCL	1.259	99% KM Chebyshev UCL	1.72

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.478	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.764	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.148	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.194	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.232	k star (bias corrected MLE)	1.087
Theta hat (MLE)	0.508	Theta star (bias corrected MLE)	0.575
nu hat (MLE)	51.72	nu star (bias corrected)	45.67

MLE Mean (bias corrected)	0.626	MLE Sd (bias corrected)	0.6

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.562	nu hat (KM)	31.47
Approximate Chi Square Value (31.47, α)	19.65	Adjusted Chi Square Value (31.47, β)	19.07
95% Gamma Approximate KM-UCL (use when n>=50)	0.771	95% Gamma Adjusted KM-UCL (use when n<50)	0.795

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.472
Maximum	2.87	Median	0.282
SD	0.661	CV	1.402
k hat (MLE)	0.569	k star (bias corrected MLE)	0.532
Theta hat (MLE)	0.829	Theta star (bias corrected MLE)	0.887
nu hat (MLE)	31.85	nu star (bias corrected)	29.77
MLE Mean (bias corrected)	0.472	MLE Sd (bias corrected)	0.647
		Adjusted Level of Significance (β)	0.0404
Approximate Chi Square Value (29.77, α)	18.31	Adjusted Chi Square Value (29.77, β)	17.75
95% Gamma Approximate UCL (use when n>=50)	0.767	95% Gamma Adjusted UCL (use when n<50)	0.791

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.975	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.908	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.116	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.193	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.48	Mean in Log Scale	-1.512
SD in Original Scale	0.656	SD in Log Scale	1.366
95% t UCL (assumes normality of ROS data)	0.691	95% Percentile Bootstrap UCL	0.709
95% BCA Bootstrap UCL	0.739	95% Bootstrap t UCL	0.903
95% H-UCL (Log ROS)	1.215		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-1.444	95% H-UCL (KM -Log)	0.964
KM SD (logged)	1.23	95% Critical H Value (KM-Log)	2.752
KM Standard Error of Mean (logged)	0.238		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.475	Mean in Log Scale	-1.618
SD in Original Scale	0.659	SD in Log Scale	1.49
95% t UCL (Assumes normality)	0.687	95% H-Stat UCL	1.471

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (Percentile Bootstrap) UCL	0.692	95% GROS Adjusted Gamma UCL	0.791
95% Adjusted Gamma KM-UCL	0.795		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper

General Statistics

Total Number of Observations	28	Number of Distinct Observations	24
		Number of Missing Observations	0
Minimum	1.9	Mean	4.455
Maximum	7.7	Median	4.5
SD	1.478	Std. Error of Mean	0.279
Coefficient of Variation	0.332	Skewness	0.063

Normal GOF Test

Shapiro Wilk Test Statistic	0.978	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.924	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.0875	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.167	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	4.93	95% Adjusted-CLT UCL (Chen-1995)	4.918
		95% Modified-t UCL (Johnson-1978)	4.931

Gamma GOF Test

A-D Test Statistic	0.37	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.746	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.102	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.165	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	8.511	k star (bias corrected MLE)	7.623
Theta hat (MLE)	0.523	Theta star (bias corrected MLE)	0.584
nu hat (MLE)	476.6	nu star (bias corrected)	426.9
MLE Mean (bias corrected)	4.455	MLE Sd (bias corrected)	1.613
		Approximate Chi Square Value (0.05)	380
Adjusted Level of Significance	0.0404	Adjusted Chi Square Value	377.3

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	5.004	95% Adjusted Gamma UCL (use when n<50)	5.041

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.949	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.924	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.127	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.167	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.642	Mean of logged Data	1.434
Maximum of Logged Data	2.041	SD of logged Data	0.366

Assuming Lognormal Distribution

95% H-UCL	5.109	90% Chebyshev (MVUE) UCL	5.426
95% Chebyshev (MVUE) UCL	5.857	97.5% Chebyshev (MVUE) UCL	6.455
99% Chebyshev (MVUE) UCL	7.629		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	4.914	95% Jackknife UCL	4.93
95% Standard Bootstrap UCL	4.909	95% Bootstrap-t UCL	4.927
95% Hall's Bootstrap UCL	4.941	95% Percentile Bootstrap UCL	4.912
95% BCA Bootstrap UCL	4.899		
90% Chebyshev(Mean, Sd) UCL	5.292	95% Chebyshev(Mean, Sd) UCL	5.672
97.5% Chebyshev(Mean, Sd) UCL	6.199	99% Chebyshev(Mean, Sd) UCL	7.233

Suggested UCL to Use

95% Student's-t UCL	4.93

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Molybdenum

General Statistics

Total Number of Observations	28	Number of Distinct Observations	28
		Number of Missing Observations	0
Minimum	0.4	Mean	2.409
Maximum	19.3	Median	1.42
SD	3.546	Std. Error of Mean	0.67
Coefficient of Variation	1.472	Skewness	4.301

Normal GOF Test

Shapiro Wilk Test Statistic	0.482	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.924	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.302	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.167	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	3.55	95% Adjusted-CLT UCL (Chen-1995)	4.093
		95% Modified-t UCL (Johnson-1978)	3.641

Gamma GOF Test

A-D Test Statistic	1.493	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.767	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.199	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.169	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.306	k star (bias corrected MLE)	1.19
Theta hat (MLE)	1.844	Theta star (bias corrected MLE)	2.024
nu hat (MLE)	73.14	nu star (bias corrected)	66.64
MLE Mean (bias corrected)	2.409	MLE Sd (bias corrected)	2.208
		Approximate Chi Square Value (0.05)	48.85
Adjusted Level of Significance	0.0404	Adjusted Chi Square Value	47.91

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	3.286	95% Adjusted Gamma UCL (use when n<50)	3.351

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.943	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.924	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.122	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.167	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.916	Mean of logged Data	0.45
Maximum of Logged Data	2.96	SD of logged Data	0.824

Assuming Lognormal Distribution

95% H-UCL	3.145	90% Chebyshev (MVUE) UCL	3.285
95% Chebyshev (MVUE) UCL	3.792	97.5% Chebyshev (MVUE) UCL	4.495
99% Chebyshev (MVUE) UCL	5.876		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3.511	95% Jackknife UCL	3.55
95% Standard Bootstrap UCL	3.483	95% Bootstrap-t UCL	5.566
95% Hall's Bootstrap UCL	7.549	95% Percentile Bootstrap UCL	3.704
95% BCA Bootstrap UCL	4.518		
90% Chebyshev(Mean, Sd) UCL	4.419	95% Chebyshev(Mean, Sd) UCL	5.33
97.5% Chebyshev(Mean, Sd) UCL	6.594	99% Chebyshev(Mean, Sd) UCL	9.077

Suggested UCL to Use

95% H-UCL	3.145

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Selenium

General Statistics

Total Number of Observations	28	Number of Distinct Observations	7
Number of Detects	7	Number of Non-Detects	21
Number of Distinct Detects	7	Number of Distinct Non-Detects	1
Minimum Detect	0.5	Minimum Non-Detect	0.5
Maximum Detect	65	Maximum Non-Detect	0.5
Variance Detects	545.4	Percent Non-Detects	75%
Mean Detects	15.56	SD Detects	23.35
Median Detects	6.5	CV Detects	1.501
Skewness Detects	2.052	Kurtosis Detects	4.198
Mean of Logged Detects	1.639	SD of Logged Detects	1.769

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.71	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.343	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.335	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	4.264	Standard Error of Mean	2.577
SD	12.62	95% KM (BCA) UCL	8.582
95% KM (t) UCL	8.654	95% KM (Percentile Bootstrap) UCL	8.614
95% KM (z) UCL	8.503	95% KM Bootstrap t UCL	23.6
90% KM Chebyshev UCL	12	95% KM Chebyshev UCL	15.5

97.5% KM Chebyshev UCL	20.36	99% KM Chebyshev UCL	29.9

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.284	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.748	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.212	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.326	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.564	k star (bias corrected MLE)	0.418
Theta hat (MLE)	27.57	Theta star (bias corrected MLE)	37.25
nu hat (MLE)	7.9	nu star (bias corrected)	5.847
MLE Mean (bias corrected)	15.56	MLE Sd (bias corrected)	24.07

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.114	nu hat (KM)	6.39
Approximate Chi Square Value (6.39, α)	1.842	Adjusted Chi Square Value (6.39, β)	1.696
95% Gamma Approximate KM-UCL (use when n>=50)	14.79	95% Gamma Adjusted KM-UCL (use when n<50)	16.07

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	3.897
Maximum	65	Median	0.01
SD	12.97	CV	3.328
k hat (MLE)	0.171	k star (bias corrected MLE)	0.177
Theta hat (MLE)	22.77	Theta star (bias corrected MLE)	22.06
nu hat (MLE)	9.584	nu star (bias corrected)	9.89
MLE Mean (bias corrected)	3.897	MLE Sd (bias corrected)	9.272
		Adjusted Level of Significance (β)	0.0404
Approximate Chi Square Value (9.89, α)	3.873	Adjusted Chi Square Value (9.89, β)	3.643
95% Gamma Approximate UCL (use when n>=50)	9.95	95% Gamma Adjusted UCL (use when n<50)	10.58

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.957	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.156	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.335	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	3.919	Mean in Log Scale	-3.815
SD in Original Scale	12.96	SD in Log Scale	4.199
95% t UCL (assumes normality of ROS data)	8.091	95% Percentile Bootstrap UCL	8.096
95% BCA Bootstrap UCL	11.5	95% Bootstrap t UCL	27.95
95% H-UCL (Log ROS)	64984		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-0.11	95% H-UCL (KM -Log)	4.255
KM SD (logged)	1.3	95% Critical H Value (KM-Log)	2.847
KM Standard Error of Mean (logged)	0.265		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	4.077	Mean in Log Scale	-0.63
SD in Original Scale	12.91	SD in Log Scale	1.573
95% t UCL (Assumes normality)	8.233	95% H-Stat UCL	4.895

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	8.654	95% GROS Adjusted Gamma UCL	10.58
95% Adjusted Gamma KM-UCL	16.07		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zinc

General Statistics

Total Number of Observations	28	Number of Distinct Observations	20
		Number of Missing Observations	0
Minimum	11	Mean	46.19
Maximum	335	Median	35
SD	60.02	Std. Error of Mean	11.34
Coefficient of Variation	1.299	Skewness	4.487

Normal GOF Test

Shapiro Wilk Test Statistic	0.423	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.924	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.39	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.167	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	65.51	95% Adjusted-CLT UCL (Chen-1995)	75.13
		95% Modified-t UCL (Johnson-1978)	67.11

Gamma GOF Test

A-D Test Statistic	2.696	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.759	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.275	**Kolmogrov-Smirnoff Gamma GOF Test**	
5% K-S Critical Value	0.168	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.837	k star (bias corrected MLE)	1.664
Theta hat (MLE)	25.15	Theta star (bias corrected MLE)	27.76
nu hat (MLE)	102.9	nu star (bias corrected)	93.18
MLE Mean (bias corrected)	46.19	MLE Sd (bias corrected)	35.81
		Approximate Chi Square Value (0.05)	71.92
Adjusted Level of Significance	0.0404	Adjusted Chi Square Value	70.77

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	59.85	95% Adjusted Gamma UCL (use when n<50)	60.83

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.847	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.924	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.197	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.167	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.398	Mean of logged Data	3.537
Maximum of Logged Data	5.814	SD of logged Data	0.654

Assuming Lognormal Distribution

95% H-UCL	55.25	90% Chebyshev (MVUE) UCL	58.88
95% Chebyshev (MVUE) UCL	66.46	97.5% Chebyshev (MVUE) UCL	76.98
99% Chebyshev (MVUE) UCL	97.63		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	64.85	95% Jackknife UCL	65.51
95% Standard Bootstrap UCL	65.03	95% Bootstrap-t UCL	129.3
95% Hall's Bootstrap UCL	158.5	95% Percentile Bootstrap UCL	66.55
95% BCA Bootstrap UCL	79.68		
90% Chebyshev(Mean, Sd) UCL	80.22	95% Chebyshev(Mean, Sd) UCL	95.63
97.5% Chebyshev(Mean, Sd) UCL	117	99% Chebyshev(Mean, Sd) UCL	159

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	95.63

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)

and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Henry Site Surface Water

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	9/3/2015 11:11:20 AM
From File	ProUCLinput-SW.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum, dissolved

General Statistics

Total Number of Observations	33	Number of Distinct Observations	8
		Number of Missing Observations	174
Number of Detects	8	Number of Non-Detects	25
Number of Distinct Detects	7	Number of Distinct Non-Detects	2
Minimum Detect	0.03	Minimum Non-Detect	0.03
Maximum Detect	0.905	Maximum Non-Detect	0.05
Variance Detects	0.13	Percent Non-Detects	75.76%
Mean Detects	0.319	SD Detects	0.361
Median Detects	0.16	CV Detects	1.133
Skewness Detects	1.098	Kurtosis Detects	-0.563
Mean of Logged Detects	-1.861	SD of Logged Detects	1.37

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.78	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.818	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.275	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.313	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.1	Standard Error of Mean	0.0386
SD	0.207	95% KM (BCA) UCL	0.166
95% KM (t) UCL	0.165	95% KM (Percentile Bootstrap) UCL	0.166
95% KM (z) UCL	0.164	95% KM Bootstrap t UCL	0.267
90% KM Chebyshev UCL	0.216	95% KM Chebyshev UCL	0.268
97.5% KM Chebyshev UCL	0.341	99% KM Chebyshev UCL	0.484

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.451	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.742	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.218	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.303	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.824	k star (bias corrected MLE)	0.598
Theta hat (MLE)	0.387	Theta star (bias corrected MLE)	0.532

nu hat (MLE)	13.19	nu star (bias corrected)	9.574
MLE Mean (bias corrected)	0.319	MLE Sd (bias corrected)	0.412

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.234	nu hat (KM)	15.43
Approximate Chi Square Value (15.43, α)	7.563	Adjusted Chi Square Value (15.43, β)	7.279
95% Gamma Approximate KM-UCL (use when n>=50)	0.204	95% Gamma Adjusted KM-UCL (use when n<50)	0.212

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0848
Maximum	0.905	Median	0.01
SD	0.216	CV	2.544
k hat (MLE)	0.44	k star (bias corrected MLE)	0.42
Theta hat (MLE)	0.193	Theta star (bias corrected MLE)	0.202
nu hat (MLE)	29.04	nu star (bias corrected)	27.74
MLE Mean (bias corrected)	0.0848	MLE Sd (bias corrected)	0.131
		Adjusted Level of Significance (β)	0.0419
Approximate Chi Square Value (27.74, α)	16.72	Adjusted Chi Square Value (27.74, β)	16.28
95% Gamma Approximate UCL (use when n>=50)	0.141	95% Gamma Adjusted UCL (use when n<50)	0.144

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.894	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.818	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.214	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.313	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0804	Mean in Log Scale	-5.612
SD in Original Scale	0.217	SD in Log Scale	2.829
95% t UCL (assumes normality of ROS data)	0.144	95% Percentile Bootstrap UCL	0.148
95% BCA Bootstrap UCL	0.163	95% Bootstrap t UCL	0.263
95% H-UCL (Log ROS)	2.652		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-3.102	95% H-UCL (KM -Log)	0.104
KM SD (logged)	0.945	95% Critical H Value (KM-Log)	2.375
KM Standard Error of Mean (logged)	0.176		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0907	Mean in Log Scale	-3.524
SD in Original Scale	0.214	SD in Log Scale	1.168
95% t UCL (Assumes normality)	0.154	95% H-Stat UCL	0.101

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.165	95% KM (Percentile Bootstrap) UCL	0.166

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Antimony, dissolved

General Statistics

Total Number of Observations	30	Number of Distinct Observations	6
		Number of Missing Observations	175
Number of Detects	5	Number of Non-Detects	25
Number of Distinct Detects	5	Number of Distinct Non-Detects	2
Minimum Detect	4.0000E-4	Minimum Non-Detect	4.0000E-4
Maximum Detect	0.0023	Maximum Non-Detect	0.003
Variance Detects	6.1700E-7	Percent Non-Detects	83.33%
Mean Detects	9.2000E-4	SD Detects	7.8549E-4
Median Detects	6.0000E-4	CV Detects	0.854
Skewness Detects	2.045	Kurtosis Detects	4.286
Mean of Logged Detects	-7.21	SD of Logged Detects	0.683

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.722	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.361	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.396	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	5.0833E-4	Standard Error of Mean	8.7628E-5
SD	3.8397E-4	95% KM (BCA) UCL	6.6364E-4
95% KM (t) UCL	6.5722E-4	95% KM (Percentile Bootstrap) UCL	6.6296E-4
95% KM (z) UCL	6.5247E-4	95% KM Bootstrap t UCL	9.8324E-4
90% KM Chebyshev UCL	7.7122E-4	95% KM Chebyshev UCL	8.9030E-4
97.5% KM Chebyshev UCL	0.00106	99% KM Chebyshev UCL	0.00138

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.559	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.684	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.298	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.36	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.44	k star (bias corrected MLE)	1.109
Theta hat (MLE)	3.7708E-4	Theta star (bias corrected MLE)	8.2940E-4
nu hat (MLE)	24.4	nu star (bias corrected)	11.09
MLE Mean (bias corrected)	9.2000E-4	MLE Sd (bias corrected)	8.7352E-4

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	1.753	nu hat (KM)	105.2
Approximate Chi Square Value (105.16, α)	82.5	Adjusted Chi Square Value (105.16, β)	81.34
95% Gamma Approximate KM-UCL (use when n>=50)	6.4799E-4	95% Gamma Adjusted KM-UCL (use when n<50)	6.5720E-4

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	4.0000E-4	Mean	0.00849
Maximum	0.01	Median	0.01
SD	0.00345	CV	0.407
k hat (MLE)	2.002	k star (bias corrected MLE)	1.824
Theta hat (MLE)	0.00424	Theta star (bias corrected MLE)	0.00465
nu hat (MLE)	120.1	nu star (bias corrected)	109.5
MLE Mean (bias corrected)	0.00849	MLE Sd (bias corrected)	0.00628
		Adjusted Level of Significance (β)	0.041
Approximate Chi Square Value (109.46, α)	86.31	Adjusted Chi Square Value (109.46, β)	85.13
95% Gamma Approximate UCL (use when n>=50)	0.0108	95% Gamma Adjusted UCL (use when n<50)	0.0109

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.871	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.254	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.396	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.1693E-4	Mean in Log Scale	-9.731
SD in Original Scale	4.4232E-4	SD in Log Scale	1.708
95% t UCL (assumes normality of ROS data)	3.5414E-4	95% Percentile Bootstrap UCL	3.6670E-4
95% BCA Bootstrap UCL	4.2594E-4	95% Bootstrap t UCL	5.4777E-4
95% H-UCL (Log ROS)	7.6999E-4		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-7.696	95% H-UCL (KM -Log)	5.5471E-4
KM SD (logged)	0.374	95% Critical H Value (KM-Log)	1.856
KM Standard Error of Mean (logged)	0.0854		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	5.8000E-4	Mean in Log Scale	-7.896

SD in Original Scale	6.1218E-4	SD in Log Scale	0.895
95% t UCL (Assumes normality)	7.6991E-4	95% H-Stat UCL	8.2014E-4

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	6.5722E-4	95% KM (Percentile Bootstrap) UCL	6.6296E-4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic, dissolved

General Statistics

Total Number of Observations	30	Number of Distinct Observations	15
		Number of Missing Observations	175
Number of Detects	16	Number of Non-Detects	14
Number of Distinct Detects	14	Number of Distinct Non-Detects	1
Minimum Detect	5.3000E-4	Minimum Non-Detect	5.0000E-4
Maximum Detect	0.0224	Maximum Non-Detect	5.0000E-4
Variance Detects	5.0046E-5	Percent Non-Detects	46.67%
Mean Detects	0.0049	SD Detects	0.00707
Median Detects	0.00125	CV Detects	1.445
Skewness Detects	1.794	Kurtosis Detects	2.05
Mean of Logged Detects	-6.149	SD of Logged Detects	1.259

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.656	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.887	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.379	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.222	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.00284	Standard Error of Mean	0.00103
SD	0.00546	95% KM (BCA) UCL	0.00468
95% KM (t) UCL	0.00459	95% KM (Percentile Bootstrap) UCL	0.00454
95% KM (z) UCL	0.00454	95% KM Bootstrap t UCL	0.00617
90% KM Chebyshev UCL	0.00593	95% KM Chebyshev UCL	0.00733
97.5% KM Chebyshev UCL	0.00928	99% KM Chebyshev UCL	0.0131

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.402	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.777	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.284	**Kolmogrov-Smirnoff GOF**

5% K-S Critical Value	0.224	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.725	k star (bias corrected MLE)	0.631
Theta hat (MLE)	0.00675	Theta star (bias corrected MLE)	0.00776
nu hat (MLE)	23.19	nu star (bias corrected)	20.18
MLE Mean (bias corrected)	0.0049	MLE Sd (bias corrected)	0.00617

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.271	nu hat (KM)	16.27
Approximate Chi Square Value (16.27, α)	8.154	Adjusted Chi Square Value (16.27, β)	7.823
95% Gamma Approximate KM-UCL (use when n>=50)	0.00568	95% Gamma Adjusted KM-UCL (use when n<50)	0.00592

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	5.3000E-4	Mean	0.00728
Maximum	0.0224	Median	0.01
SD	0.00571	CV	0.784
k hat (MLE)	1.126	k star (bias corrected MLE)	1.036
Theta hat (MLE)	0.00646	Theta star (bias corrected MLE)	0.00703
nu hat (MLE)	67.57	nu star (bias corrected)	62.14
MLE Mean (bias corrected)	0.00728	MLE Sd (bias corrected)	0.00715
		Adjusted Level of Significance (β)	0.041
Approximate Chi Square Value (62.14, α)	45.01	Adjusted Chi Square Value (62.14, β)	44.17
95% Gamma Approximate UCL (use when n>=50)	0.01	95% Gamma Adjusted UCL (use when n<50)	0.0102

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.868	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.887	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.216	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.222	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00266	Mean in Log Scale	-7.761
SD in Original Scale	0.00564	SD in Log Scale	2.117
95% t UCL (assumes normality of ROS data)	0.00441	95% Percentile Bootstrap UCL	0.00437
95% BCA Bootstrap UCL	0.00496	95% Bootstrap t UCL	0.00623
95% H-UCL (Log ROS)	0.0203		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-6.827	95% H-UCL (KM -Log)	0.0037
KM SD (logged)	1.148	95% Critical H Value (KM-Log)	2.669
KM Standard Error of Mean (logged)	0.216		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.00273	Mean in Log Scale	-7.15
SD in Original Scale	0.00561	SD in Log Scale	1.416
95% t UCL (Assumes normality)	0.00447	95% H-Stat UCL	0.00476

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

97.5% KM (Chebyshev) UCL	0.00928

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Barium, dissolved

General Statistics

Total Number of Observations	24	Number of Distinct Observations	19
		Number of Missing Observations	181
Minimum	0.006	Mean	0.0441
Maximum	0.081	Median	0.041
SD	0.0193	Std. Error of Mean	0.00395
Coefficient of Variation	0.439	Skewness	-0.0915

Normal GOF Test

Shapiro Wilk Test Statistic	0.972	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.916	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.126	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.181	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	0.0509	95% Adjusted-CLT UCL (Chen-1995)	0.0505
		95% Modified-t UCL (Johnson-1978)	0.0509

Gamma GOF Test

A-D Test Statistic	0.728	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.749	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.172	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.179	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.726	k star (bias corrected MLE)	3.288
Theta hat (MLE)	0.0118	Theta star (bias corrected MLE)	0.0134
nu hat (MLE)	178.8	nu star (bias corrected)	157.8
MLE Mean (bias corrected)	0.0441	MLE Sd (bias corrected)	0.0243
		Approximate Chi Square Value (0.05)	129.8
Adjusted Level of Significance	0.0392	Adjusted Chi Square Value	128

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.0536	95% Adjusted Gamma UCL (use when n<50)	0.0544

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.825	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.916	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.216	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.181	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-5.116	Mean of logged Data	-3.262
Maximum of Logged Data	-2.513	SD of logged Data	0.628

Assuming Lognormal Distribution

95% H-UCL	0.0614	90% Chebyshev (MVUE) UCL	0.0651
95% Chebyshev (MVUE) UCL	0.0736	97.5% Chebyshev (MVUE) UCL	0.0855
99% Chebyshev (MVUE) UCL	0.109		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.0506	95% Jackknife UCL	0.0509
95% Standard Bootstrap UCL	0.0504	95% Bootstrap-t UCL	0.0513
95% Hall's Bootstrap UCL	0.0509	95% Percentile Bootstrap UCL	0.0506
95% BCA Bootstrap UCL	0.0504		
90% Chebyshev(Mean, Sd) UCL	0.0559	95% Chebyshev(Mean, Sd) UCL	0.0613
97.5% Chebyshev(Mean, Sd) UCL	0.0688	99% Chebyshev(Mean, Sd) UCL	0.0834

Suggested UCL to Use

95% Student's-t UCL	0.0509

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Boron, dissolved

General Statistics

Total Number of Observations	12	Number of Distinct Observations	8
		Number of Missing Observations	193
Number of Detects	9	Number of Non-Detects	3
Number of Distinct Detects	7	Number of Distinct Non-Detects	2
Minimum Detect	0.01	Minimum Non-Detect	0.002
Maximum Detect	0.121	Maximum Non-Detect	0.01
Variance Detects	0.00196	Percent Non-Detects	25%
Mean Detects	0.0422	SD Detects	0.0443
Median Detects	0.02	CV Detects	1.049
Skewness Detects	1.442	Kurtosis Detects	0.411
Mean of Logged Detects	-3.591	SD of Logged Detects	0.94

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.711	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.296	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.295	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.0322	Standard Error of Mean	0.0123
SD	0.0401	95% KM (BCA) UCL	0.0533
95% KM (t) UCL	0.0542	95% KM (Percentile Bootstrap) UCL	0.0525
95% KM (z) UCL	0.0524	95% KM Bootstrap t UCL	0.0981
90% KM Chebyshev UCL	0.069	95% KM Chebyshev UCL	0.0857
97.5% KM Chebyshev UCL	0.109	99% KM Chebyshev UCL	0.154

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.716	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.738	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.231	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.285	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.317	k star (bias corrected MLE)	0.952
Theta hat (MLE)	0.032	Theta star (bias corrected MLE)	0.0443
nu hat (MLE)	23.71	nu star (bias corrected)	17.14
MLE Mean (bias corrected)	0.0422	MLE Sd (bias corrected)	0.0432

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.642	nu hat (KM)	15.41
Approximate Chi Square Value (15.41, α)	7.547	Adjusted Chi Square Value (15.41, β)	6.724
95% Gamma Approximate KM-UCL (use when n>=50)	0.0656	95% Gamma Adjusted KM-UCL (use when n<50)	0.0737

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0342
Maximum	0.121	Median	0.0173
SD	0.0405	CV	1.185
k hat (MLE)	1.209	k star (bias corrected MLE)	0.963
Theta hat (MLE)	0.0282	Theta star (bias corrected MLE)	0.0355
nu hat (MLE)	29.02	nu star (bias corrected)	23.1
MLE Mean (bias corrected)	0.0342	MLE Sd (bias corrected)	0.0348
		Adjusted Level of Significance (β)	0.029
Approximate Chi Square Value (23.10, α)	13.17	Adjusted Chi Square Value (23.10, β)	12.04
95% Gamma Approximate UCL (use when n>=50)	0.0599	95% Gamma Adjusted UCL (use when n<50)	0.0655

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.882	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.189	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.295	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0324	Mean in Log Scale	-4.16
SD in Original Scale	0.0417	SD in Log Scale	1.311
95% t UCL (assumes normality of ROS data)	0.054	95% Percentile Bootstrap UCL	0.0515
95% BCA Bootstrap UCL	0.06	95% Bootstrap t UCL	0.0913
95% H-UCL (Log ROS)	0.148		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-4.247	95% H-UCL (KM -Log)	0.164
KM SD (logged)	1.371	95% Critical H Value (KM-Log)	3.63
KM Standard Error of Mean (logged)	0.42		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0326	Mean in Log Scale	-4.152
SD in Original Scale	0.0416	SD in Log Scale	1.352
95% t UCL (Assumes normality)	0.0541	95% H-Stat UCL	0.17

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.0857	95% GROS Adjusted Gamma UCL	0.0655
95% Adjusted Gamma KM-UCL	0.0737		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium, dissolved

General Statistics

Total Number of Observations	125	Number of Distinct Observations	22
		Number of Missing Observations	124
Number of Detects	20	Number of Non-Detects	105
Number of Distinct Detects	18	Number of Distinct Non-Detects	6
Minimum Detect	1.2000E-5	Minimum Non-Detect	1.0000E-4
Maximum Detect	0.0352	Maximum Non-Detect	6.0000E-4
Variance Detects	1.1874E-4	Percent Non-Detects	84%
Mean Detects	0.00591	SD Detects	0.0109
Median Detects	2.0000E-4	CV Detects	1.843
Skewness Detects	1.881	Kurtosis Detects	2.433
Mean of Logged Detects	-7.517	SD of Logged Detects	2.5

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.611	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.905	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.381	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.198	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	9.7729E-4	Standard Error of Mean	4.3726E-4
SD	0.00476	95% KM (BCA) UCL	0.00177
95% KM (t) UCL	0.0017	95% KM (Percentile Bootstrap) UCL	0.00176
95% KM (z) UCL	0.0017	95% KM Bootstrap t UCL	0.00222
90% KM Chebyshev UCL	0.00229	95% KM Chebyshev UCL	0.00288
97.5% KM Chebyshev UCL	0.00371	99% KM Chebyshev UCL	0.00533

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.496	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.849	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.269	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.211	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.29	k star (bias corrected MLE)	0.28
Theta hat (MLE)	0.0204	Theta star (bias corrected MLE)	0.0211
nu hat (MLE)	11.62	nu star (bias corrected)	11.21
MLE Mean (bias corrected)	0.00591	MLE Sd (bias corrected)	0.0112

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.0421	nu hat (KM)	10.52
Approximate Chi Square Value (10.52, α)	4.272	Adjusted Chi Square Value (10.52, β)	4.225

95% Gamma Approximate KM-UCL (use when n>=50)	0.00241	95% Gamma Adjusted KM-UCL (use when n<50)	0.00243

Gamma (KM) may not be used when k hat (KM) is < 0.1

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	1.2000E-5	Mean	0.00935
Maximum	0.0352	Median	0.01
SD	0.00452	CV	0.484
k hat (MLE)	1.399	k star (bias corrected MLE)	1.371
Theta hat (MLE)	0.00668	Theta star (bias corrected MLE)	0.00682
nu hat (MLE)	349.7	nu star (bias corrected)	342.6
MLE Mean (bias corrected)	0.00935	MLE Sd (bias corrected)	0.00798
		Adjusted Level of Significance (β)	0.0481
Approximate Chi Square Value (342.63, α)	300.7	Adjusted Chi Square Value (342.63, β)	300.3
95% Gamma Approximate UCL (use when n>=50)	0.0106	95% Gamma Adjusted UCL (use when n<50)	0.0107

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.918	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.905	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.205	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.198	Detected Data Not Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	9.8824E-4	Mean in Log Scale	-10.63
SD in Original Scale	0.00478	SD in Log Scale	2.427
95% t UCL (assumes normality of ROS data)	0.0017	95% Percentile Bootstrap UCL	0.00174
95% BCA Bootstrap UCL	0.00201	95% Bootstrap t UCL	0.00246
95% H-UCL (Log ROS)	0.00105		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-10.03	95% H-UCL (KM -Log)	2.4578E-4
KM SD (logged)	1.62	95% Critical H Value (KM-Log)	2.816
KM Standard Error of Mean (logged)	0.332		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00102	Mean in Log Scale	-9.171
SD in Original Scale	0.00477	SD in Log Scale	1.319
95% t UCL (Assumes normality)	0.00173	95% H-Stat UCL	3.3361E-4

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

97.5% KM (Chebyshev) UCL	0.00371

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chromium, dissolved

General Statistics

Total Number of Observations	71	Number of Distinct Observations	23
		Number of Missing Observations	136
Number of Detects	37	Number of Non-Detects	34
Number of Distinct Detects	22	Number of Distinct Non-Detects	3
Minimum Detect	2.0000E-4	Minimum Non-Detect	1.0000E-4
Maximum Detect	0.0076	Maximum Non-Detect	5.0000E-4
Variance Detects	3.7235E-6	Percent Non-Detects	47.89%
Mean Detects	0.00142	SD Detects	0.00193
Median Detects	5.0000E-4	CV Detects	1.358
Skewness Detects	2.211	Kurtosis Detects	4.571
Mean of Logged Detects	-7.214	SD of Logged Detects	1.088

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.647	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.936	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.306	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.146	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	7.9155E-4	Standard Error of Mean	1.8329E-4
SD	0.00152	95% KM (BCA) UCL	0.00111
95% KM (t) UCL	0.0011	95% KM (Percentile Bootstrap) UCL	0.00111
95% KM (z) UCL	0.00109	95% KM Bootstrap t UCL	0.00123
90% KM Chebyshev UCL	0.00134	95% KM Chebyshev UCL	0.00159
97.5% KM Chebyshev UCL	0.00194	99% KM Chebyshev UCL	0.00262

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.758	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.782	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.259	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.15	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.89	k star (bias corrected MLE)	0.836
Theta hat (MLE)	0.0016	Theta star (bias corrected MLE)	0.0017
nu hat (MLE)	65.9	nu star (bias corrected)	61.89
MLE Mean (bias corrected)	0.00142	MLE Sd (bias corrected)	0.00155

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.27	nu hat (KM)	38.34
Approximate Chi Square Value (38.34, α)	25.16	Adjusted Chi Square Value (38.34, β)	24.94
95% Gamma Approximate KM-UCL (use when n>=50)	0.00121	95% Gamma Adjusted KM-UCL (use when n<50)	0.00122

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	2.0000E-4	Mean	0.00553
Maximum	0.01	Median	0.0076
SD	0.00453	CV	0.82
k hat (MLE)	0.777	k star (bias corrected MLE)	0.754
Theta hat (MLE)	0.00712	Theta star (bias corrected MLE)	0.00734
nu hat (MLE)	110.3	nu star (bias corrected)	107
MLE Mean (bias corrected)	0.00553	MLE Sd (bias corrected)	0.00637
		Adjusted Level of Significance (β)	0.0466
Approximate Chi Square Value (107.00, α)	84.13	Adjusted Chi Square Value (107.00, β)	83.71
95% Gamma Approximate UCL (use when n>=50)	0.00703	95% Gamma Adjusted UCL (use when n<50)	0.00707

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.869	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.936	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.213	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.146	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	7.7179E-4	Mean in Log Scale	-8.55
SD in Original Scale	0.00154	SD in Log Scale	1.739
95% t UCL (assumes normality of ROS data)	0.00108	95% Percentile Bootstrap UCL	0.00108
95% BCA Bootstrap UCL	0.00117	95% Bootstrap t UCL	0.00119
95% H-UCL (Log ROS)	0.00166		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	7.7380E-4	Mean in Log Scale	-8.424
SD in Original Scale	0.00154	SD in Log Scale	1.527
95% t UCL (Assumes normality)	0.00108	95% H-Stat UCL	0.00118

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.00159

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cobalt, dissolved

General Statistics

Total Number of Observations	30	Number of Distinct Observations	7
		Number of Missing Observations	175
Number of Detects	6	Number of Non-Detects	24
Number of Distinct Detects	6	Number of Distinct Non-Detects	1
Minimum Detect	9.6400E-4	Minimum Non-Detect	0.01
Maximum Detect	0.0141	Maximum Non-Detect	0.01
Variance Detects	3.5409E-5	Percent Non-Detects	80%
Mean Detects	0.00603	SD Detects	0.00595
Median Detects	0.00287	CV Detects	0.987
Skewness Detects	0.916	Kurtosis Detects	-1.804
Mean of Logged Detects	-5.562	SD of Logged Detects	1.061

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.756	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.36	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.362	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.00298	Standard Error of Mean	6.9812E-4
SD	0.00295	95% KM (BCA) UCL	0.00404
95% KM (t) UCL	0.00417	95% KM (Percentile Bootstrap) UCL	0.00409
95% KM (z) UCL	0.00413	95% KM Bootstrap t UCL	0.00452
90% KM Chebyshev UCL	0.00508	95% KM Chebyshev UCL	0.00603
97.5% KM Chebyshev UCL	0.00734	99% KM Chebyshev UCL	0.00993

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.568	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.711	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.313	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.339	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.249	k star (bias corrected MLE)	0.735
Theta hat (MLE)	0.00483	Theta star (bias corrected MLE)	0.0082
nu hat (MLE)	14.98	nu star (bias corrected)	8.826
MLE Mean (bias corrected)	0.00603	MLE Sd (bias corrected)	0.00703

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	1.021	nu hat (KM)	61.23
Approximate Chi Square Value (61.23, α)	44.24	Adjusted Chi Square Value (61.23, β)	43.4
95% Gamma Approximate KM-UCL (use when n>=50)	0.00413	95% Gamma Adjusted KM-UCL (use when n<50)	0.00421

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	9.6400E-4	Mean	0.00921
Maximum	0.0141	Median	0.01
SD	0.00295	CV	0.321
k hat (MLE)	4.762	k star (bias corrected MLE)	4.308
Theta hat (MLE)	0.00193	Theta star (bias corrected MLE)	0.00214
nu hat (MLE)	285.7	nu star (bias corrected)	258.5
MLE Mean (bias corrected)	0.00921	MLE Sd (bias corrected)	0.00444
		Adjusted Level of Significance (β)	0.041
Approximate Chi Square Value (258.50, α)	222.3	Adjusted Chi Square Value (258.50, β)	220.3
95% Gamma Approximate UCL (use when n>=50)	0.0107	95% Gamma Adjusted UCL (use when n<50)	0.0108

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.892	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.255	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.362	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00332	Mean in Log Scale	-6.056
SD in Original Scale	0.00327	SD in Log Scale	0.835
95% t UCL (assumes normality of ROS data)	0.00434	95% Percentile Bootstrap UCL	0.00432
95% BCA Bootstrap UCL	0.00461	95% Bootstrap t UCL	0.00508
95% H-UCL (Log ROS)	0.00473		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-6.069	95% H-UCL (KM -Log)	0.00364
KM SD (logged)	0.642	95% Critical H Value (KM-Log)	2.078
KM Standard Error of Mean (logged)	0.248		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00521	Mean in Log Scale	-5.351
SD in Original Scale	0.00251	SD in Log Scale	0.453
95% t UCL (Assumes normality)	0.00598	95% H-Stat UCL	0.00618

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.00417	95% KM (Percentile Bootstrap) UCL	0.00409

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper, dissolved

General Statistics

Total Number of Observations	30	Number of Distinct Observations	7
		Number of Missing Observations	175
Number of Detects	6	Number of Non-Detects	24
Number of Distinct Detects	6	Number of Distinct Non-Detects	1
Minimum Detect	5.5000E-4	Minimum Non-Detect	0.01
Maximum Detect	0.00379	Maximum Non-Detect	0.01
Variance Detects	1.7635E-6	Percent Non-Detects	80%
Mean Detects	0.00171	SD Detects	0.00133
Median Detects	0.00124	CV Detects	0.779
Skewness Detects	0.838	Kurtosis Detects	-0.859
Mean of Logged Detects	-6.646	SD of Logged Detects	0.817

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.861	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.275	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.362	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.00171	Standard Error of Mean	5.4214E-4
SD	0.00121	95% KM (BCA) UCL	0.00275
95% KM (t) UCL	0.00263	95% KM (Percentile Bootstrap) UCL	0.00271
95% KM (z) UCL	0.0026	95% KM Bootstrap t UCL	0.00356
90% KM Chebyshev UCL	0.00333	95% KM Chebyshev UCL	0.00407
97.5% KM Chebyshev UCL	0.00509	99% KM Chebyshev UCL	0.0071

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.458	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.704	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.3	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.336	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.991	k star (bias corrected MLE)	1.106
Theta hat (MLE)	8.5646E-4	Theta star (bias corrected MLE)	0.00154
nu hat (MLE)	23.89	nu star (bias corrected)	13.28

MLE Mean (bias corrected)	0.00171	MLE Sd (bias corrected)	0.00162

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	1.978	nu hat (KM)	118.7
Approximate Chi Square Value (118.69, α)	94.53	Adjusted Chi Square Value (118.69, β)	93.29
95% Gamma Approximate KM-UCL (use when n>=50)	0.00214	95% Gamma Adjusted KM-UCL (use when n<50)	0.00217

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	5.5000E-4	Mean	0.00834
Maximum	0.01	Median	0.01
SD	0.00342	CV	0.41
k hat (MLE)	2.358	k star (bias corrected MLE)	2.145
Theta hat (MLE)	0.00354	Theta star (bias corrected MLE)	0.00389
nu hat (MLE)	141.5	nu star (bias corrected)	128.7
MLE Mean (bias corrected)	0.00834	MLE Sd (bias corrected)	0.0057
		Adjusted Level of Significance (β)	0.041
Approximate Chi Square Value (128.69, α)	103.5	Adjusted Chi Square Value (128.69, β)	102.2
95% Gamma Approximate UCL (use when n>=50)	0.0104	95% Gamma Adjusted UCL (use when n<50)	0.0105

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.879	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.275	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.362	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00187	Mean in Log Scale	-6.646
SD in Original Scale	0.00169	SD in Log Scale	0.881
95% t UCL (assumes normality of ROS data)	0.00239	95% Percentile Bootstrap UCL	0.00237
95% BCA Bootstrap UCL	0.00248	95% Bootstrap t UCL	0.00255
95% H-UCL (Log ROS)	0.00281		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-6.646	95% H-UCL (KM -Log)	0.00232
KM SD (logged)	0.746	95% Critical H Value (KM-Log)	2.183
KM Standard Error of Mean (logged)	0.334		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.00434	Mean in Log Scale	-5.568
SD in Original Scale	0.00145	SD in Log Scale	0.645
95% t UCL (Assumes normality)	0.00479	95% H-Stat UCL	0.00603

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.00263	95% KM (Percentile Bootstrap) UCL	0.00271

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Manganese, dissolved

General Statistics

Total Number of Observations	39	Number of Distinct Observations	37
		Number of Missing Observations	168
Number of Detects	37	Number of Non-Detects	2
Number of Distinct Detects	36	Number of Distinct Non-Detects	1
Minimum Detect	0.0012	Minimum Non-Detect	5.0000E-4
Maximum Detect	2.44	Maximum Non-Detect	5.0000E-4
Variance Detects	0.361	Percent Non-Detects	5.128%
Mean Detects	0.241	SD Detects	0.601
Median Detects	0.0204	CV Detects	2.496
Skewness Detects	3.091	Kurtosis Detects	8.698
Mean of Logged Detects	-3.526	SD of Logged Detects	2.007

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.442	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.936	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.377	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.146	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.228	Standard Error of Mean	0.0941
SD	0.58	95% KM (BCA) UCL	0.403
95% KM (t) UCL	0.387	95% KM (Percentile Bootstrap) UCL	0.401
95% KM (z) UCL	0.383	95% KM Bootstrap t UCL	0.518
90% KM Chebyshev UCL	0.511	95% KM Chebyshev UCL	0.639
97.5% KM Chebyshev UCL	0.816	99% KM Chebyshev UCL	1.165

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	3.237	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.852	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.247	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.157	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.324	k star (bias corrected MLE)	0.316
Theta hat (MLE)	0.743	Theta star (bias corrected MLE)	0.763
nu hat (MLE)	23.97	nu star (bias corrected)	23.36
MLE Mean (bias corrected)	0.241	MLE Sd (bias corrected)	0.429

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.155	nu hat (KM)	12.11
Approximate Chi Square Value (12.11, α)	5.297	Adjusted Chi Square Value (12.11, β)	5.119
95% Gamma Approximate KM-UCL (use when n>=50)	0.522	95% Gamma Adjusted KM-UCL (use when n<50)	0.54

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0012	Mean	0.229
Maximum	2.44	Median	0.0196
SD	0.587	CV	2.565
k hat (MLE)	0.323	k star (bias corrected MLE)	0.316
Theta hat (MLE)	0.708	Theta star (bias corrected MLE)	0.726
nu hat (MLE)	25.22	nu star (bias corrected)	24.61
MLE Mean (bias corrected)	0.229	MLE Sd (bias corrected)	0.408
		Adjusted Level of Significance (β)	0.0437
Approximate Chi Square Value (24.61, α)	14.31	Adjusted Chi Square Value (24.61, β)	14
95% Gamma Approximate UCL (use when n>=50)	0.394	95% Gamma Adjusted UCL (use when n<50)	0.402

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.936	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.936	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.13	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.146	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.228	Mean in Log Scale	-3.772
SD in Original Scale	0.587	SD in Log Scale	2.23
95% t UCL (assumes normality of ROS data)	0.387	95% Percentile Bootstrap UCL	0.392
95% BCA Bootstrap UCL	0.446	95% Bootstrap t UCL	0.503
95% H-UCL (Log ROS)	1.222		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-3.735	95% H-UCL (KM -Log)	0.898
KM SD (logged)	2.128	95% Critical H Value (KM-Log)	3.951
KM Standard Error of Mean (logged)	0.345		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.228	Mean in Log Scale	-3.771
SD in Original Scale	0.587	SD in Log Scale	2.225

95% t UCL (Assumes normality)	0.387	95% H-Stat UCL	1.204

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

99% KM (Chebyshev) UCL	1.165

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Molybdenum, dissolved

General Statistics

Total Number of Observations	30	Number of Distinct Observations	9
		Number of Missing Observations	175
Number of Detects	8	Number of Non-Detects	22
Number of Distinct Detects	7	Number of Distinct Non-Detects	2
Minimum Detect	0.0037	Minimum Non-Detect	6.0000E-4
Maximum Detect	0.04	Maximum Non-Detect	0.01
Variance Detects	1.8608E-4	Percent Non-Detects	73.33%
Mean Detects	0.019	SD Detects	0.0136
Median Detects	0.0192	CV Detects	0.717
Skewness Detects	0.211	Kurtosis Detects	-1.397
Mean of Logged Detects	-4.289	SD of Logged Detects	0.954

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.903	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.818	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.204	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.313	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.00765	Standard Error of Mean	0.00205
SD	0.00967	95% KM (BCA) UCL	0.0113
95% KM (t) UCL	0.0111	95% KM (Percentile Bootstrap) UCL	0.0113
95% KM (z) UCL	0.011	95% KM Bootstrap t UCL	0.0114
90% KM Chebyshev UCL	0.0138	95% KM Chebyshev UCL	0.0166
97.5% KM Chebyshev UCL	0.0205	99% KM Chebyshev UCL	0.0281

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.513	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.727	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.229	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.298	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.672	k star (bias corrected MLE)	1.128
Theta hat (MLE)	0.0114	Theta star (bias corrected MLE)	0.0169
nu hat (MLE)	26.75	nu star (bias corrected)	18.05
MLE Mean (bias corrected)	0.019	MLE Sd (bias corrected)	0.0179

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.626	nu hat (KM)	37.54
Approximate Chi Square Value (37.54, α)	24.51	Adjusted Chi Square Value (37.54, β)	23.9
95% Gamma Approximate KM-UCL (use when n>=50)	0.0117	95% Gamma Adjusted KM-UCL (use when n<50)	0.012

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0037	Mean	0.0127
Maximum	0.04	Median	0.01
SD	0.00782	CV	0.613
k hat (MLE)	4	k star (bias corrected MLE)	3.623
Theta hat (MLE)	0.00319	Theta star (bias corrected MLE)	0.00352
nu hat (MLE)	240	nu star (bias corrected)	217.4
MLE Mean (bias corrected)	0.0127	MLE Sd (bias corrected)	0.0067
		Adjusted Level of Significance (β)	0.041
Approximate Chi Square Value (217.36, α)	184.2	Adjusted Chi Square Value (217.36, β)	182.5
95% Gamma Approximate UCL (use when n>=50)	0.015	95% Gamma Adjusted UCL (use when n<50)	0.0152

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.86	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.818	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.261	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.313	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00825	Mean in Log Scale	-5.373
SD in Original Scale	0.00984	SD in Log Scale	1.102
95% t UCL (assumes normality of ROS data)	0.0113	95% Percentile Bootstrap UCL	0.0112
95% BCA Bootstrap UCL	0.0121	95% Bootstrap t UCL	0.013
95% H-UCL (Log ROS)	0.0145		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-5.519	95% H-UCL (KM -Log)	0.0147
KM SD (logged)	1.183	95% Critical H Value (KM-Log)	2.716
KM Standard Error of Mean (logged)	0.433		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.00859	Mean in Log Scale	-5.123
SD in Original Scale	0.00931	SD in Log Scale	0.861
95% t UCL (Assumes normality)	0.0115	95% H-Stat UCL	0.0125

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.0111	95% KM (Percentile Bootstrap) UCL	0.0113

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel, dissolved

General Statistics

Total Number of Observations	88	Number of Distinct Observations	65
		Number of Missing Observations	119
Number of Detects	81	Number of Non-Detects	7
Number of Distinct Detects	62	Number of Distinct Non-Detects	4
Minimum Detect	3.0000E-4	Minimum Non-Detect	2.0000E-4
Maximum Detect	1.26	Maximum Non-Detect	0.001
Variance Detects	0.0264	Percent Non-Detects	7.955%
Mean Detects	0.0374	SD Detects	0.162
Median Detects	0.00291	CV Detects	4.342
Skewness Detects	6.179	Kurtosis Detects	42.38
Mean of Logged Detects	-5.55	SD of Logged Detects	1.535

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.254	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.465	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0984	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.0344	Standard Error of Mean	0.0166
SD	0.155	95% KM (BCA) UCL	0.0657
95% KM (t) UCL	0.0621	95% KM (Percentile Bootstrap) UCL	0.0668
95% KM (z) UCL	0.0618	95% KM Bootstrap t UCL	0.102
90% KM Chebyshev UCL	0.0844	95% KM Chebyshev UCL	0.107
97.5% KM Chebyshev UCL	0.138	99% KM Chebyshev UCL	0.2

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	14.35	**Anderson-Darling GOF Test**

5% A-D Critical Value	0.864	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.32	**Kolmogrov-Smirnoff GOF**	
5% K-S Critical Value	0.108	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.304	k star (bias corrected MLE)	0.301
Theta hat (MLE)	0.123	Theta star (bias corrected MLE)	0.124
nu hat (MLE)	49.25	nu star (bias corrected)	48.76
MLE Mean (bias corrected)	0.0374	MLE Sd (bias corrected)	0.0682

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.0493	nu hat (KM)	8.675
Approximate Chi Square Value (8.67, α)	3.132	Adjusted Chi Square Value (8.67, β)	3.076
95% Gamma Approximate KM-UCL (use when n>=50)	0.0954	95% Gamma Adjusted KM-UCL (use when n<50)	0.0971

Gamma (KM) may not be used when k hat (KM) is < 0.1

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	3.0000E-4	Mean	0.0352
Maximum	1.26	Median	0.00317
SD	0.156	CV	4.426
k hat (MLE)	0.321	k star (bias corrected MLE)	0.317
Theta hat (MLE)	0.11	Theta star (bias corrected MLE)	0.111
nu hat (MLE)	56.41	nu star (bias corrected)	55.82
MLE Mean (bias corrected)	0.0352	MLE Sd (bias corrected)	0.0625
		Adjusted Level of Significance (β)	0.0473
Approximate Chi Square Value (55.82, α)	39.65	Adjusted Chi Square Value (55.82, β)	39.43
95% Gamma Approximate UCL (use when n>=50)	0.0496	95% Gamma Adjusted UCL (use when n<50)	0.0499

Lognormal GOF Test on Detected Observations Only

Lilliefors Test Statistic	0.153	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0984	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0344	Mean in Log Scale	-5.804
SD in Original Scale	0.156	SD in Log Scale	1.714
95% t UCL (assumes normality of ROS data)	0.0621	95% Percentile Bootstrap UCL	0.0646
95% BCA Bootstrap UCL	0.0808	95% Bootstrap t UCL	0.104
95% H-UCL (Log ROS)	0.0229		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0344	Mean in Log Scale	-5.79
SD in Original Scale	0.156	SD in Log Scale	1.694

95% t UCL (Assumes normality)	0.0621	95% H-Stat UCL	0.0222

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

97.5% KM (Chebyshev) UCL	0.138

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Selenium, total

General Statistics

Total Number of Observations	126	Number of Distinct Observations	71
		Number of Missing Observations	125
Number of Detects	86	Number of Non-Detects	40
Number of Distinct Detects	70	Number of Distinct Non-Detects	3
Minimum Detect	5.8500E-4	Minimum Non-Detect	5.0000E-4
Maximum Detect	0.97	Maximum Non-Detect	0.005
Variance Detects	0.0203	Percent Non-Detects	31.75%
Mean Detects	0.0515	SD Detects	0.142
Median Detects	0.005	CV Detects	2.762
Skewness Detects	4.294	Kurtosis Detects	21.87
Mean of Logged Detects	-5.021	SD of Logged Detects	1.863

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.421	Normal GOF Test on Detected Observations Only
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.383	Lilliefors GOF Test
5% Lilliefors Critical Value	0.0955	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.0354	Standard Error of Mean	0.0107
SD	0.119	95% KM (BCA) UCL	0.0544
95% KM (t) UCL	0.0531	95% KM (Percentile Bootstrap) UCL	0.0548
95% KM (z) UCL	0.053	95% KM Bootstrap t UCL	0.0658
90% KM Chebyshev UCL	0.0675	95% KM Chebyshev UCL	0.082
97.5% KM Chebyshev UCL	0.102	99% KM Chebyshev UCL	0.142

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	8.519	Anderson-Darling GOF Test
5% A-D Critical Value	0.859	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.25	Kolmogrov-Smirnoff GOF
5% K-S Critical Value	0.104	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.33	k star (bias corrected MLE)	0.327
Theta hat (MLE)	0.156	Theta star (bias corrected MLE)	0.158
nu hat (MLE)	56.81	nu star (bias corrected)	56.16
MLE Mean (bias corrected)	0.0515	MLE Sd (bias corrected)	0.0902

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.0881	nu hat (KM)	22.21
Approximate Chi Square Value (22.21, α)	12.5	Adjusted Chi Square Value (22.21, β)	12.41
95% Gamma Approximate KM-UCL (use when n>=50)	0.0629	95% Gamma Adjusted KM-UCL (use when n<50)	0.0634

Gamma (KM) may not be used when k hat (KM) is < 0.1

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	5.8500E-4	Mean	0.0384
Maximum	0.97	Median	0.01
SD	0.119	CV	3.102
k hat (MLE)	0.404	k star (bias corrected MLE)	0.399
Theta hat (MLE)	0.095	Theta star (bias corrected MLE)	0.096
nu hat (MLE)	101.7	nu star (bias corrected)	100.6
MLE Mean (bias corrected)	0.0384	MLE Sd (bias corrected)	0.0607
		Adjusted Level of Significance (β)	0.0481
Approximate Chi Square Value (100.64, α)	78.49	Adjusted Chi Square Value (100.64, β)	78.27
95% Gamma Approximate UCL (use when n>=50)	0.0492	95% Gamma Adjusted UCL (use when n<50)	0.0493

Lognormal GOF Test on Detected Observations Only

Lilliefors Test Statistic	0.126	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0955	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0353	Mean in Log Scale	-6.086
SD in Original Scale	0.12	SD in Log Scale	2.315
95% t UCL (assumes normality of ROS data)	0.053	95% Percentile Bootstrap UCL	0.0537
95% BCA Bootstrap UCL	0.0599	95% Bootstrap t UCL	0.0615
95% H-UCL (Log ROS)	0.0704		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0353	Mean in Log Scale	-5.843
SD in Original Scale	0.12	SD in Log Scale	1.965
95% t UCL (Assumes normality)	0.053	95% H-Stat UCL	0.0351

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

97.5% KM (Chebyshev) UCL	0.102

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Thallium, dissolved

General Statistics

Total Number of Observations	30	Number of Distinct Observations	7
		Number of Missing Observations	175
Number of Detects	5	Number of Non-Detects	25
Number of Distinct Detects	4	Number of Distinct Non-Detects	3
Minimum Detect	5.9000E-5	Minimum Non-Detect	2.0000E-6
Maximum Detect	3.4800E-4	Maximum Non-Detect	1.0000E-4
Variance Detects	1.4238E-8	Percent Non-Detects	83.33%
Mean Detects	1.7420E-4	SD Detects	1.1932E-4
Median Detects	2.0000E-4	CV Detects	0.685
Skewness Detects	0.593	Kurtosis Detects	-0.373
Mean of Logged Detects	-8.878	SD of Logged Detects	0.781

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.888	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.222	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.396	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	4.8153E-5	Standard Error of Mean	1.9499E-5
SD	7.5834E-5	95% KM (BCA) UCL	N/A
95% KM (t) UCL	8.1285E-5	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	8.0227E-5	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	1.0665E-4	95% KM Chebyshev UCL	1.3315E-4
97.5% KM Chebyshev UCL	1.6993E-4	99% KM Chebyshev UCL	2.4217E-4

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.443	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.684	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.268	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.36	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.394	k star (bias corrected MLE)	1.091
Theta hat (MLE)	7.2763E-5	Theta star (bias corrected MLE)	1.5968E-4
nu hat (MLE)	23.94	nu star (bias corrected)	10.91
MLE Mean (bias corrected)	1.7420E-4	MLE Sd (bias corrected)	1.6678E-4

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.403	nu hat (KM)	24.19
Approximate Chi Square Value (24.19, α)	14	Adjusted Chi Square Value (24.19, β)	13.55
95% Gamma Approximate KM-UCL (use when n>=50)	8.3240E-5	95% Gamma Adjusted KM-UCL (use when n<50)	8.5990E-5

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	5.9000E-5	Mean	0.00836
Maximum	0.01	Median	0.01
SD	0.00372	CV	0.445
k hat (MLE)	1.073	k star (bias corrected MLE)	0.988
Theta hat (MLE)	0.00779	Theta star (bias corrected MLE)	0.00846
nu hat (MLE)	64.41	nu star (bias corrected)	59.3
MLE Mean (bias corrected)	0.00836	MLE Sd (bias corrected)	0.00841
		Adjusted Level of Significance (β)	0.041
Approximate Chi Square Value (59.30, α)	42.59	Adjusted Chi Square Value (59.30, β)	41.78
95% Gamma Approximate UCL (use when n>=50)	0.0116	95% Gamma Adjusted UCL (use when n<50)	0.0119

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.866	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.278	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.396	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	5.7308E-5	Mean in Log Scale	-10.36
SD in Original Scale	7.4217E-5	SD in Log Scale	1.096
95% t UCL (assumes normality of ROS data)	8.0332E-5	95% Percentile Bootstrap UCL	8.0366E-5
95% BCA Bootstrap UCL	8.7545E-5	95% Bootstrap t UCL	9.5459E-5
95% H-UCL (Log ROS)	9.8449E-5		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-11.41	95% H-UCL (KM -Log)	2.5199E-4
KM SD (logged)	1.896	95% Critical H Value (KM-Log)	3.77
KM Standard Error of Mean (logged)	0.784		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	6.5833E-5	Mean in Log Scale	-10.1
SD in Original Scale	6.7891E-5	SD in Log Scale	1.28

95% t UCL (Assumes normality)	8.6894E-5	95% H-Stat UCL	1.8320E-4

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	8.1285E-5	95% KM (Percentile Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Uranium, dissolved

General Statistics

Total Number of Observations	52	Number of Distinct Observations	33
		Number of Missing Observations	153
Number of Detects	49	Number of Non-Detects	3
Number of Distinct Detects	32	Number of Distinct Non-Detects	1
Minimum Detect	7.0000E-4	Minimum Non-Detect	1.0000E-4
Maximum Detect	0.0206	Maximum Non-Detect	1.0000E-4
Variance Detects	1.7473E-5	Percent Non-Detects	5.769%
Mean Detects	0.00356	SD Detects	0.00418
Median Detects	0.0019	CV Detects	1.174
Skewness Detects	2.335	Kurtosis Detects	5.521
Mean of Logged Detects	-6.071	SD of Logged Detects	0.857

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.657	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.947	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.305	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.127	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.00336	Standard Error of Mean	5.7395E-4
SD	0.0041	95% KM (BCA) UCL	0.00431
95% KM (t) UCL	0.00432	95% KM (Percentile Bootstrap) UCL	0.00437
95% KM (z) UCL	0.00431	95% KM Bootstrap t UCL	0.00464
90% KM Chebyshev UCL	0.00508	95% KM Chebyshev UCL	0.00586
97.5% KM Chebyshev UCL	0.00695	99% KM Chebyshev UCL	0.00907

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	3.329	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.772	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.241	**Kolmogrov-Smirnoff GOF**

5% K-S Critical Value	0.129	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.295	k star (bias corrected MLE)	1.229
Theta hat (MLE)	0.00275	Theta star (bias corrected MLE)	0.0029
nu hat (MLE)	126.9	nu star (bias corrected)	120.5
MLE Mean (bias corrected)	0.00356	MLE Sd (bias corrected)	0.00321

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.674	nu hat (KM)	70.05
Approximate Chi Square Value (70.05, α)	51.78	Adjusted Chi Square Value (70.05, β)	51.33
95% Gamma Approximate KM-UCL (use when n>=50)	0.00455	95% Gamma Adjusted KM-UCL (use when n<50)	0.00459

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	7.0000E-4	Mean	0.00393
Maximum	0.0206	Median	0.00199
SD	0.00433	CV	1.101
k hat (MLE)	1.256	k star (bias corrected MLE)	1.197
Theta hat (MLE)	0.00313	Theta star (bias corrected MLE)	0.00329
nu hat (MLE)	130.7	nu star (bias corrected)	124.5
MLE Mean (bias corrected)	0.00393	MLE Sd (bias corrected)	0.0036
		Adjusted Level of Significance (β)	0.0454
Approximate Chi Square Value (124.47, α)	99.7	Adjusted Chi Square Value (124.47, β)	99.07
95% Gamma Approximate UCL (use when n>=50)	0.00491	95% Gamma Adjusted UCL (use when n<50)	0.00494

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.898	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.947	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.176	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.127	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00337	Mean in Log Scale	-6.186
SD in Original Scale	0.00413	SD in Log Scale	0.956
95% t UCL (assumes normality of ROS data)	0.00433	95% Percentile Bootstrap UCL	0.00434
95% BCA Bootstrap UCL	0.00453	95% Bootstrap t UCL	0.00468
95% H-UCL (Log ROS)	0.0044		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00336	Mean in Log Scale	-6.292
SD in Original Scale	0.00414	SD in Log Scale	1.227
95% t UCL (Assumes normality)	0.00432	95% H-Stat UCL	0.00612

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.00586

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Vanadium, dissolved

General Statistics

Total Number of Observations	123	Number of Distinct Observations	64
		Number of Missing Observations	126
Number of Detects	72	Number of Non-Detects	51
Number of Distinct Detects	58	Number of Distinct Non-Detects	6
Minimum Detect	4.0000E-4	Minimum Non-Detect	5.0000E-5
Maximum Detect	0.0885	Maximum Non-Detect	0.025
Variance Detects	2.6956E-4	Percent Non-Detects	41.46%
Mean Detects	0.00742	SD Detects	0.0164
Median Detects	0.00193	CV Detects	2.214
Skewness Detects	3.484	Kurtosis Detects	12.32
Mean of Logged Detects	-6.016	SD of Logged Detects	1.274

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.457	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.341	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.104	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.00478	Standard Error of Mean	0.00117
SD	0.0129	95% KM (BCA) UCL	0.00649
95% KM (t) UCL	0.00672	95% KM (Percentile Bootstrap) UCL	0.00681
95% KM (z) UCL	0.0067	95% KM Bootstrap t UCL	0.00761
90% KM Chebyshev UCL	0.00829	95% KM Chebyshev UCL	0.00989
97.5% KM Chebyshev UCL	0.0121	99% KM Chebyshev UCL	0.0164

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	7.371	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.811	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.256	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.111	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.561	k star (bias corrected MLE)	0.547
Theta hat (MLE)	0.0132	Theta star (bias corrected MLE)	0.0136
nu hat (MLE)	80.84	nu star (bias corrected)	78.81
MLE Mean (bias corrected)	0.00742	MLE Sd (bias corrected)	0.01

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.137	nu hat (KM)	33.82
Approximate Chi Square Value (33.82, α)	21.52	Adjusted Chi Square Value (33.82, β)	21.4
95% Gamma Approximate KM-UCL (use when n>=50)	0.00751	95% Gamma Adjusted KM-UCL (use when n<50)	0.00755

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	4.0000E-4	Mean	0.00852
Maximum	0.0885	Median	0.00862
SD	0.0126	CV	1.478
k hat (MLE)	0.884	k star (bias corrected MLE)	0.868
Theta hat (MLE)	0.00964	Theta star (bias corrected MLE)	0.00982
nu hat (MLE)	217.5	nu star (bias corrected)	213.5
MLE Mean (bias corrected)	0.00852	MLE Sd (bias corrected)	0.00915
		Adjusted Level of Significance (β)	0.048
Approximate Chi Square Value (213.53, α)	180.7	Adjusted Chi Square Value (213.53, β)	180.4
95% Gamma Approximate UCL (use when n>=50)	0.0101	95% Gamma Adjusted UCL (use when n<50)	0.0101

Lognormal GOF Test on Detected Observations Only

Lilliefors Test Statistic	0.141	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.104	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00486	Mean in Log Scale	-6.571
SD in Original Scale	0.0129	SD in Log Scale	1.423
95% t UCL (assumes normality of ROS data)	0.00679	95% Percentile Bootstrap UCL	0.0069
95% BCA Bootstrap UCL	0.00758	95% Bootstrap t UCL	0.00775
95% H-UCL (Log ROS)	0.00538		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0053	Mean in Log Scale	-6.318
SD in Original Scale	0.0129	SD in Log Scale	1.448
95% t UCL (Assumes normality)	0.00723	95% H-Stat UCL	0.00726

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.00989

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zinc, dissolved

General Statistics

Total Number of Observations	88	Number of Distinct Observations	29
		Number of Missing Observations	119
Number of Detects	58	Number of Non-Detects	30
Number of Distinct Detects	29	Number of Distinct Non-Detects	4
Minimum Detect	8.0000E-4	Minimum Non-Detect	0.002
Maximum Detect	4.73	Maximum Non-Detect	0.01
Variance Detects	0.488	Percent Non-Detects	34.09%
Mean Detects	0.156	SD Detects	0.699
Median Detects	0.005	CV Detects	4.48
Skewness Detects	5.607	Kurtosis Detects	34.01
Mean of Logged Detects	-4.897	SD of Logged Detects	1.703

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.251	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.48	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.116	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.103	Standard Error of Mean	0.061
SD	0.567	95% KM (BCA) UCL	0.233
95% KM (t) UCL	0.205	95% KM (Percentile Bootstrap) UCL	0.22
95% KM (z) UCL	0.203	95% KM Bootstrap t UCL	0.336
90% KM Chebyshev UCL	0.286	95% KM Chebyshev UCL	0.369
97.5% KM Chebyshev UCL	0.484	99% KM Chebyshev UCL	0.71

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	13.14	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.896	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.407	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.129	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.236	k star (bias corrected MLE)	0.235
Theta hat (MLE)	0.661	Theta star (bias corrected MLE)	0.663

nu hat (MLE)	27.37	nu star (bias corrected)	27.28
MLE Mean (bias corrected)	0.156	MLE Sd (bias corrected)	0.321

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.0331	nu hat (KM)	5.83
Approximate Chi Square Value (5.83, α)	1.554	Adjusted Chi Square Value (5.83, β)	1.518
95% Gamma Approximate KM-UCL (use when n>=50)	0.387	95% Gamma Adjusted KM-UCL (use when n<50)	0.396

Gamma (KM) may not be used when k hat (KM) is < 0.1

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	8.0000E-4	Mean	0.106
Maximum	4.73	Median	0.01
SD	0.57	CV	5.366
k hat (MLE)	0.274	k star (bias corrected MLE)	0.272
Theta hat (MLE)	0.388	Theta star (bias corrected MLE)	0.39
nu hat (MLE)	48.21	nu star (bias corrected)	47.9
MLE Mean (bias corrected)	0.106	MLE Sd (bias corrected)	0.204
		Adjusted Level of Significance (β)	0.0473
Approximate Chi Square Value (47.90, α)	33.01	Adjusted Chi Square Value (47.90, β)	32.81
95% Gamma Approximate UCL (use when n>=50)	0.154	95% Gamma Adjusted UCL (use when n<50)	0.155

Lognormal GOF Test on Detected Observations Only

Lilliefors Test Statistic	0.206	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.116	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.103	Mean in Log Scale	-5.867
SD in Original Scale	0.57	SD in Log Scale	2.033
95% t UCL (assumes normality of ROS data)	0.204	95% Percentile Bootstrap UCL	0.214
95% BCA Bootstrap UCL	0.267	95% Bootstrap t UCL	0.333
95% H-UCL (Log ROS)	0.0472		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.103	Mean in Log Scale	-5.481
SD in Original Scale	0.57	SD in Log Scale	1.633
95% t UCL (Assumes normality)	0.204	95% H-Stat UCL	0.0264

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

97.5% KM (Chebyshev) UCL	0.484

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Henry Site Surface Water

From Locations With Fish Present or Likely to be Present

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	5/24/2016 8:42:03 AM
From File	ProUCLinput-SW-fish present.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Arsenic, dissolved

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	82
Minimum	5.3000E-4	Mean	6.4000E-4
Maximum	7.5000E-4	Median	6.4000E-4

Warning: This data set only has 2 observations!

Data set is too small to compute reliable and meaningful statistics and estimates!

The data set for variable Arsenic, dissolved was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!

If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Cadmium, dissolved

General Statistics

Total Number of Observations	37	Number of Distinct Observations	7
		Number of Missing Observations	106
Number of Detects	1	Number of Non-Detects	36
Number of Distinct Detects	1	Number of Distinct Non-Detects	6

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!

It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Cadmium, dissolved was not processed!

Chromium, dissolved

General Statistics

Total Number of Observations	14	Number of Distinct Observations	7
		Number of Missing Observations	84
Number of Detects	5	Number of Non-Detects	9
Number of Distinct Detects	5	Number of Distinct Non-Detects	2
Minimum Detect	2.3000E-4	Minimum Non-Detect	1.0000E-4

Maximum Detect	0.00142	Maximum Non-Detect	5.0000E-4
Variance Detects	2.9503E-7	Percent Non-Detects	64.29%
Mean Detects	7.6600E-4	SD Detects	5.4317E-4
Median Detects	5.9000E-4	CV Detects	0.709
Skewness Detects	0.411	Kurtosis Detects	-2.8
Mean of Logged Detects	-7.413	SD of Logged Detects	0.801

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.873	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.227	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.396	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	3.4043E-4	Standard Error of Mean	1.2882E-4
SD	4.3058E-4	95% KM (BCA) UCL	5.5857E-4
95% KM (t) UCL	5.6855E-4	95% KM (Percentile Bootstrap) UCL	5.4224E-4
95% KM (z) UCL	5.5231E-4	95% KM Bootstrap t UCL	6.5716E-4
90% KM Chebyshev UCL	7.2688E-4	95% KM Chebyshev UCL	9.0192E-4
97.5% KM Chebyshev UCL	0.00114	99% KM Chebyshev UCL	0.00162

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.352	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.684	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.248	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.36	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.251	k star (bias corrected MLE)	1.034
Theta hat (MLE)	3.4029E-4	Theta star (bias corrected MLE)	7.4099E-4
nu hat (MLE)	22.51	nu star (bias corrected)	10.34
MLE Mean (bias corrected)	7.6600E-4	MLE Sd (bias corrected)	7.5339E-4

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.625	nu hat (KM)	17.5
Approximate Chi Square Value (17.50, α)	9.032	Adjusted Chi Square Value (17.50, β)	8.236
95% Gamma Approximate KM-UCL (use when n>=50)	6.5967E-4	95% Gamma Adjusted KM-UCL (use when n<50)	7.2349E-4

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	2.3000E-4	Mean	0.0067
Maximum	0.01	Median	0.01
SD	0.0046	CV	0.687

k hat (MLE)	0.962	k star (bias corrected MLE)	0.804
Theta hat (MLE)	0.00696	Theta star (bias corrected MLE)	0.00834
nu hat (MLE)	26.95	nu star (bias corrected)	22.51
MLE Mean (bias corrected)	0.0067	MLE Sd (bias corrected)	0.00748
		Adjusted Level of Significance (β)	0.0312
Approximate Chi Square Value (22.51, α)	12.72	Adjusted Chi Square Value (22.51, β)	11.75
95% Gamma Approximate UCL (use when n>=50)	0.0119	95% Gamma Adjusted UCL (use when n<50)	0.0128

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.915	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.221	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.396	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	3.1413E-4	Mean in Log Scale	-9.048
SD in Original Scale	4.6278E-4	SD in Log Scale	1.509
95% t UCL (assumes normality of ROS data)	5.3317E-4	95% Percentile Bootstrap UCL	5.2121E-4
95% BCA Bootstrap UCL	5.8099E-4	95% Bootstrap t UCL	8.7160E-4
95% H-UCL (Log ROS)	0.00173		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-8.554	95% H-UCL (KM -Log)	6.3193E-4
KM SD (logged)	0.96	95% Critical H Value (KM-Log)	2.727
KM Standard Error of Mean (logged)	0.289		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	3.2000E-4	Mean in Log Scale	-8.899
SD in Original Scale	4.6100E-4	SD in Log Scale	1.302
95% t UCL (Assumes normality)	5.3819E-4	95% H-Stat UCL	0.00106

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	5.6855E-4	95% KM (Percentile Bootstrap) UCL	5.4224E-4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cobalt, dissolved

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	82
Number of Detects	1	Number of Non-Detects	1
Number of Distinct Detects	1	Number of Distinct Non-Detects	1

Warning: This data set only has 2 observations!

Data set is too small to compute reliable and meaningful statistics and estimates!

The data set for variable Cobalt, dissolved was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!

If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Manganese, dissolved

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	93
Minimum	0.00265	Mean	0.0084
Maximum	0.0121	Median	0.00887
SD	0.00349	Std. Error of Mean	0.00156
Coefficient of Variation	0.415	Skewness	-1.345

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.872	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.334	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.396	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.0117	95% Adjusted-CLT UCL (Chen-1995)	0.00996
		95% Modified-t UCL (Johnson-1978)	0.0116

Gamma GOF Test

A-D Test Statistic	0.678	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.681	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.392	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.358	Data Not Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.647	k star (bias corrected MLE)	1.992
Theta hat (MLE)	0.00181	Theta star (bias corrected MLE)	0.00422
nu hat (MLE)	46.47	nu star (bias corrected)	19.92
MLE Mean (bias corrected)	0.0084	MLE Sd (bias corrected)	0.00595
		Approximate Chi Square Value (0.05)	10.79
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	8.021

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.0155	95% Adjusted Gamma UCL (use when n<50)	0.0209

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.751	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.397	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.396	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-5.933	Mean of logged Data	-4.891
Maximum of Logged Data	-4.415	SD of logged Data	0.597

Assuming Lognormal Distribution

95% H-UCL	0.0239	90% Chebyshev (MVUE) UCL	0.0155
95% Chebyshev (MVUE) UCL	0.0186	97.5% Chebyshev (MVUE) UCL	0.0228
99% Chebyshev (MVUE) UCL	0.0313		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.011	95% Jackknife UCL	0.0117
95% Standard Bootstrap UCL	0.0107	95% Bootstrap-t UCL	0.0106
95% Hall's Bootstrap UCL	0.0102	95% Percentile Bootstrap UCL	0.0103
95% BCA Bootstrap UCL	0.0103		
90% Chebyshev(Mean, Sd) UCL	0.0131	95% Chebyshev(Mean, Sd) UCL	0.0152
97.5% Chebyshev(Mean, Sd) UCL	0.0181	99% Chebyshev(Mean, Sd) UCL	0.0239

Suggested UCL to Use

95% Student's-t UCL	0.0117

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Nickel, dissolved

General Statistics

Total Number of Observations	20	Number of Distinct Observations	17
		Number of Missing Observations	86
Number of Detects	19	Number of Non-Detects	1
Number of Distinct Detects	16	Number of Distinct Non-Detects	1
Minimum Detect	5.0000E-4	Minimum Non-Detect	0.001
Maximum Detect	0.00634	Maximum Non-Detect	0.001
Variance Detects	1.9342E-6	Percent Non-Detects	5%
Mean Detects	0.00205	SD Detects	0.00139
Median Detects	0.00187	CV Detects	0.677
Skewness Detects	1.725	Kurtosis Detects	3.975
Mean of Logged Detects	-6.379	SD of Logged Detects	0.635

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.847	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.901	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.155	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.203	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.00199	Standard Error of Mean	3.0977E-4
SD	0.00135	95% KM (BCA) UCL	0.00255
95% KM (t) UCL	0.00253	95% KM (Percentile Bootstrap) UCL	0.00251
95% KM (z) UCL	0.0025	95% KM Bootstrap t UCL	0.00274
90% KM Chebyshev UCL	0.00292	95% KM Chebyshev UCL	0.00334
97.5% KM Chebyshev UCL	0.00393	99% KM Chebyshev UCL	0.00507

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.277	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.749	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.127	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.2	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.774	k star (bias corrected MLE)	2.371
Theta hat (MLE)	7.4065E-4	Theta star (bias corrected MLE)	8.6650E-4
nu hat (MLE)	105.4	nu star (bias corrected)	90.09
MLE Mean (bias corrected)	0.00205	MLE Sd (bias corrected)	0.00133

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	2.183	nu hat (KM)	87.34
Approximate Chi Square Value (87.34, α)	66.79	Adjusted Chi Square Value (87.34, β)	65.37
95% Gamma Approximate KM-UCL (use when n>=50)	0.0026	95% Gamma Adjusted KM-UCL (use when n<50)	0.00266

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	5.0000E-4	Mean	0.00245
Maximum	0.01	Median	0.00193
SD	0.00223	CV	0.911
k hat (MLE)	1.942	k star (bias corrected MLE)	1.684
Theta hat (MLE)	0.00126	Theta star (bias corrected MLE)	0.00146
nu hat (MLE)	77.67	nu star (bias corrected)	67.35
MLE Mean (bias corrected)	0.00245	MLE Sd (bias corrected)	0.00189
		Adjusted Level of Significance (β)	0.038
Approximate Chi Square Value (67.35, α)	49.47	Adjusted Chi Square Value (67.35, β)	48.25
95% Gamma Approximate UCL (use when n>=50)	0.00334	95% Gamma Adjusted UCL (use when n<50)	0.00342

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.982	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.901	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.104	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.203	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00199	Mean in Log Scale	-6.417
SD in Original Scale	0.00138	SD in Log Scale	0.641
95% t UCL (assumes normality of ROS data)	0.00253	95% Percentile Bootstrap UCL	0.00253
95% BCA Bootstrap UCL	0.00262	95% Bootstrap t UCL	0.00279
95% H-UCL (Log ROS)	0.00276		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-6.418	95% H-UCL (KM -Log)	0.00271
KM SD (logged)	0.627	95% Critical H Value (KM-Log)	2.153
KM Standard Error of Mean (logged)	0.145		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.00198	Mean in Log Scale	-6.44
SD in Original Scale	0.0014	SD in Log Scale	0.675
95% t UCL (Assumes normality)	0.00252	95% H-Stat UCL	0.00282

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.00253	95% KM (Percentile Bootstrap) UCL	0.00251

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Selenium, total

General Statistics

Total Number of Observations	37	Number of Distinct Observations	22
		Number of Missing Observations	109
Number of Detects	19	Number of Non-Detects	18
Number of Distinct Detects	19	Number of Distinct Non-Detects	3
Minimum Detect	6.7500E-4	Minimum Non-Detect	5.0000E-4
Maximum Detect	0.046	Maximum Non-Detect	0.005
Variance Detects	1.0641E-4	Percent Non-Detects	48.65%
Mean Detects	0.00342	SD Detects	0.0103
Median Detects	9.8800E-4	CV Detects	3.016
Skewness Detects	4.353	Kurtosis Detects	18.96
Mean of Logged Detects	-6.69	SD of Logged Detects	0.914

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.267	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.901	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.507	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.203	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.00215	Standard Error of Mean	0.00124
SD	0.00731	95% KM (BCA) UCL	0.0046
95% KM (t) UCL	0.00423	95% KM (Percentile Bootstrap) UCL	0.00459
95% KM (z) UCL	0.00418	95% KM Bootstrap t UCL	0.0399
90% KM Chebyshev UCL	0.00585	95% KM Chebyshev UCL	0.00753
97.5% KM Chebyshev UCL	0.00986	99% KM Chebyshev UCL	0.0144

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	5.23	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.792	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.442	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.208	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.609	k star (bias corrected MLE)	0.548
Theta hat (MLE)	0.00562	Theta star (bias corrected MLE)	0.00624
nu hat (MLE)	23.14	nu star (bias corrected)	20.82
MLE Mean (bias corrected)	0.00342	MLE Sd (bias corrected)	0.00462

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.0862	nu hat (KM)	6.379
Approximate Chi Square Value (6.38, α)	1.837	Adjusted Chi Square Value (6.38, β)	1.733
95% Gamma Approximate KM-UCL (use when n>=50)	0.00746	95% Gamma Adjusted KM-UCL (use when n<50)	0.0079

Gamma (KM) may not be used when k hat (KM) is < 0.1

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	6.7500E-4	Mean	0.00662
Maximum	0.046	Median	0.01
SD	0.00802	CV	1.211
k hat (MLE)	0.889	k star (bias corrected MLE)	0.835
Theta hat (MLE)	0.00745	Theta star (bias corrected MLE)	0.00793
nu hat (MLE)	65.81	nu star (bias corrected)	61.8
MLE Mean (bias corrected)	0.00662	MLE Sd (bias corrected)	0.00725
		Adjusted Level of Significance (β)	0.0431
Approximate Chi Square Value (61.80, α)	44.72	Adjusted Chi Square Value (61.80, β)	44.09
95% Gamma Approximate UCL (use when n>=50)	0.00915	95% Gamma Adjusted UCL (use when n<50)	0.00928

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.511	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.901	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.333	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.203	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00211	Mean in Log Scale	-6.996
SD in Original Scale	0.00742	SD in Log Scale	0.795
95% t UCL (assumes normality of ROS data)	0.00417	95% Percentile Bootstrap UCL	0.00457
95% BCA Bootstrap UCL	0.00583	95% Bootstrap t UCL	0.0341
95% H-UCL (Log ROS)	0.00167		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00205	Mean in Log Scale	-7.108
SD in Original Scale	0.00744	SD in Log Scale	0.831
95% t UCL (Assumes normality)	0.00411	95% H-Stat UCL	0.00157

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.00423	95% KM (% Bootstrap) UCL	0.00459

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Uranium, dissolved

General Statistics

Total Number of Observations	11	Number of Distinct Observations	7
		Number of Missing Observations	85
Minimum	9.3800E-4	Mean	0.00146
Maximum	0.00207	Median	0.0014
SD	3.6996E-4	Std. Error of Mean	1.1155E-4
Coefficient of Variation	0.254	Skewness	0.423

Normal GOF Test

Shapiro Wilk Test Statistic	0.933	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.85	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.196	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.267	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.00166	95% Adjusted-CLT UCL (Chen-1995)	0.00165
		95% Modified-t UCL (Johnson-1978)	0.00166

Gamma GOF Test

A-D Test Statistic	0.322	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.729	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.168	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.255	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	17.27	k star (bias corrected MLE)	12.62
Theta hat (MLE)	8.4275E-5	Theta star (bias corrected MLE)	1.1532E-4
nu hat (MLE)	379.9	nu star (bias corrected)	277.6
MLE Mean (bias corrected)	0.00146	MLE Sd (bias corrected)	4.0966E-4
		Approximate Chi Square Value (0.05)	240

Adjusted Level of Significance	0.0278	Adjusted Chi Square Value	234.3

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.00168	95% Adjusted Gamma UCL (use when n<50)	0.00172

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.952	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.85	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.151	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.267	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-6.972	Mean of logged Data	-6.562
Maximum of Logged Data	-6.18	SD of logged Data	0.254

Assuming Lognormal Distribution

95% H-UCL	0.0017	90% Chebyshev (MVUE) UCL	0.00179
95% Chebyshev (MVUE) UCL	0.00194	97.5% Chebyshev (MVUE) UCL	0.00215
99% Chebyshev (MVUE) UCL	0.00257		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.00164	95% Jackknife UCL	0.00166
95% Standard Bootstrap UCL	0.00163	95% Bootstrap-t UCL	0.00169
95% Hall's Bootstrap UCL	0.00165	95% Percentile Bootstrap UCL	0.00163
95% BCA Bootstrap UCL	0.00165		
90% Chebyshev(Mean, Sd) UCL	0.00179	95% Chebyshev(Mean, Sd) UCL	0.00194
97.5% Chebyshev(Mean, Sd) UCL	0.00215	99% Chebyshev(Mean, Sd) UCL	0.00257

Suggested UCL to Use

95% Student's-t UCL	0.00166

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Vanadium, dissolved

General Statistics

Total Number of Observations	37	Number of Distinct Observations	21
		Number of Missing Observations	106
Number of Detects	18	Number of Non-Detects	19
Number of Distinct Detects	18	Number of Distinct Non-Detects	3
Minimum Detect	7.0000E-4	Minimum Non-Detect	3.0000E-4

Maximum Detect	0.0885	Maximum Non-Detect	0.025
Variance Detects	6.1275E-4	Percent Non-Detects	51.35%
Mean Detects	0.0108	SD Detects	0.0248
Median Detects	0.0019	CV Detects	2.291
Skewness Detects	2.781	Kurtosis Detects	6.804
Mean of Logged Detects	-5.907	SD of Logged Detects	1.41

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.45	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.897	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.43	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.209	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.00606	Standard Error of Mean	0.00295
SD	0.0174	95% KM (BCA) UCL	0.0118
95% KM (t) UCL	0.011	95% KM (Percentile Bootstrap) UCL	0.0114
95% KM (z) UCL	0.0109	95% KM Bootstrap t UCL	0.0441
90% KM Chebyshev UCL	0.0149	95% KM Chebyshev UCL	0.0189
97.5% KM Chebyshev UCL	0.0245	99% KM Chebyshev UCL	0.0354

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.703	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.807	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.328	**Kolmogrov-Smirnoff GOF**	
5% K-S Critical Value	0.216	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.466	k star (bias corrected MLE)	0.425
Theta hat (MLE)	0.0232	Theta star (bias corrected MLE)	0.0254
nu hat (MLE)	16.77	nu star (bias corrected)	15.3
MLE Mean (bias corrected)	0.0108	MLE Sd (bias corrected)	0.0166

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.121	nu hat (KM)	8.955
Approximate Chi Square Value (8.95, α)	3.3	Adjusted Chi Square Value (8.95, β)	3.152
95% Gamma Approximate KM-UCL (use when n>=50)	0.0164	95% Gamma Adjusted KM-UCL (use when n<50)	0.0172

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	7.0000E-4	Mean	0.0107
Maximum	0.0885	Median	0.01
SD	0.0171	CV	1.597

k hat (MLE)	0.868	k star (bias corrected MLE)	0.815
Theta hat (MLE)	0.0123	Theta star (bias corrected MLE)	0.0131
nu hat (MLE)	64.2	nu star (bias corrected)	60.33
MLE Mean (bias corrected)	0.0107	MLE Sd (bias corrected)	0.0118
		Adjusted Level of Significance (β)	0.0431
Approximate Chi Square Value (60.33, α)	43.46	Adjusted Chi Square Value (60.33, β)	42.84
95% Gamma Approximate UCL (use when n>=50)	0.0148	95% Gamma Adjusted UCL (use when n<50)	0.015

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.806	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.897	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.234	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.209	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00628	Mean in Log Scale	-6.309
SD in Original Scale	0.0176	SD in Log Scale	1.302
95% t UCL (assumes normality of ROS data)	0.0112	95% Percentile Bootstrap UCL	0.0118
95% BCA Bootstrap UCL	0.0135	95% Bootstrap t UCL	0.0433
95% H-UCL (Log ROS)	0.00773		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00702	Mean in Log Scale	-5.939
SD in Original Scale	0.0176	SD in Log Scale	1.142
95% t UCL (Assumes normality)	0.0119	95% H-Stat UCL	0.00822

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (BCA) UCL 0.0118

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zinc, dissolved

General Statistics

Total Number of Observations	20	Number of Distinct Observations	11
		Number of Missing Observations	86
Number of Detects	16	Number of Non-Detects	4
Number of Distinct Detects	11	Number of Distinct Non-Detects	2
Minimum Detect	8.0000E-4	Minimum Non-Detect	0.002

Maximum Detect	0.0141	Maximum Non-Detect	0.01
Variance Detects	1.3223E-5	Percent Non-Detects	20%
Mean Detects	0.00606	SD Detects	0.00364
Median Detects	0.005	CV Detects	0.6
Skewness Detects	0.763	Kurtosis Detects	0.00502
Mean of Logged Detects	-5.309	SD of Logged Detects	0.719

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.934	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.887	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.239	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.222	Detected Data Not Normal at 5% Significance Level	

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.00515	Standard Error of Mean	8.6478E-4
SD	0.00371	95% KM (BCA) UCL	0.00686
95% KM (t) UCL	0.00664	95% KM (Percentile Bootstrap) UCL	0.0066
95% KM (z) UCL	0.00657	95% KM Bootstrap t UCL	0.00685
90% KM Chebyshev UCL	0.00774	95% KM Chebyshev UCL	0.00891
97.5% KM Chebyshev UCL	0.0105	99% KM Chebyshev UCL	0.0137

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.265	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.747	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.161	**Kolmogrov-Smirnoff GOF**	
5% K-S Critical Value	0.217	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.631	k star (bias corrected MLE)	2.179
Theta hat (MLE)	0.0023	Theta star (bias corrected MLE)	0.00278
nu hat (MLE)	84.19	nu star (bias corrected)	69.74
MLE Mean (bias corrected)	0.00606	MLE Sd (bias corrected)	0.0041

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	1.923	nu hat (KM)	76.91
Approximate Chi Square Value (76.91, α)	57.71	Adjusted Chi Square Value (76.91, β)	56.39
95% Gamma Approximate KM-UCL (use when n>=50)	0.00686	95% Gamma Adjusted KM-UCL (use when n<50)	0.00702

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	8.0000E-4	Mean	0.00684
Maximum	0.0141	Median	0.006
SD	0.00361	CV	0.528

k hat (MLE)	2.878	k star (bias corrected MLE)	2.48
Theta hat (MLE)	0.00238	Theta star (bias corrected MLE)	0.00276
nu hat (MLE)	115.1	nu star (bias corrected)	99.18
MLE Mean (bias corrected)	0.00684	MLE Sd (bias corrected)	0.00435
		Adjusted Level of Significance (β)	0.038
Approximate Chi Square Value (99.18, α)	77.21	Adjusted Chi Square Value (99.18, β)	75.68
95% Gamma Approximate UCL (use when n>=50)	0.00879	95% Gamma Adjusted UCL (use when n<50)	0.00897

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.936	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.887	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.134	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.222	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0052	Mean in Log Scale	-5.532
SD in Original Scale	0.00369	SD in Log Scale	0.81
95% t UCL (assumes normality of ROS data)	0.00663	95% Percentile Bootstrap UCL	0.00667
95% BCA Bootstrap UCL	0.00669	95% Bootstrap t UCL	0.00688
95% H-UCL (Log ROS)	0.00854		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-5.611	95% H-UCL (KM -Log)	0.00948
KM SD (logged)	0.919	95% Critical H Value (KM-Log)	2.518
KM Standard Error of Mean (logged)	0.217		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00524	Mean in Log Scale	-5.548
SD in Original Scale	0.00372	SD in Log Scale	0.867
95% t UCL (Assumes normality)	0.00668	95% H-Stat UCL	0.00922

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.00664	95% KM (Percentile Bootstrap) UCL	0.0066

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Henry Site Sediment

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	6/19/2015 12:44:13 PM
From File	ProUCLinput-SE.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Antimony

General Statistics

Total Number of Observations	18	Number of Distinct Observations	12
Number of Detects	13	Number of Non-Detects	5
Number of Distinct Detects	11	Number of Distinct Non-Detects	1
Minimum Detect	3.6	Minimum Non-Detect	3
Maximum Detect	8.5	Maximum Non-Detect	3
Variance Detects	2.654	Percent Non-Detects	27.78%
Mean Detects	6.062	SD Detects	1.629
Median Detects	5.5	CV Detects	0.269
Skewness Detects	0.252	Kurtosis Detects	-1.276
Mean of Logged Detects	1.768	SD of Logged Detects	0.274

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.932	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.866	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.173	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.246	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	5.211	Standard Error of Mean	0.469
SD	1.91	95% KM (BCA) UCL	6.006
95% KM (t) UCL	6.026	95% KM (Percentile Bootstrap) UCL	5.917
95% KM (z) UCL	5.982	95% KM Bootstrap t UCL	6.065
90% KM Chebyshev UCL	6.617	95% KM Chebyshev UCL	7.254
97.5% KM Chebyshev UCL	8.138	99% KM Chebyshev UCL	9.874

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.344	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.734	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.149	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.236	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	14.85	k star (bias corrected MLE)	11.47
Theta hat (MLE)	0.408	Theta star (bias corrected MLE)	0.528
nu hat (MLE)	386	nu star (bias corrected)	298.3

MLE Mean (bias corrected)	6.062	MLE Sd (bias corrected)	1.79

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	7.44	nu hat (KM)	267.8
Approximate Chi Square Value (267.85, α)	230.9	Adjusted Chi Square Value (267.85, β)	227.7
95% Gamma Approximate KM-UCL (use when n>=50)	6.044	95% Gamma Adjusted KM-UCL (use when n<50)	6.131

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	1.644	Mean	5.103
Maximum	8.5	Median	5
SD	2.125	CV	0.416
k hat (MLE)	5.424	k star (bias corrected MLE)	4.557
Theta hat (MLE)	0.941	Theta star (bias corrected MLE)	1.12
nu hat (MLE)	195.3	nu star (bias corrected)	164
MLE Mean (bias corrected)	5.103	MLE Sd (bias corrected)	2.39
		Adjusted Level of Significance (β)	0.0357
Approximate Chi Square Value (164.05, α)	135.4	Adjusted Chi Square Value (164.05, β)	132.9
95% Gamma Approximate UCL (use when n>=50)	6.181	95% Gamma Adjusted UCL (use when n<50)	6.297

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.947	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.866	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.13	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.246	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	5.223	Mean in Log Scale	1.583
SD in Original Scale	1.965	SD in Log Scale	0.391
95% t UCL (assumes normality of ROS data)	6.028	95% Percentile Bootstrap UCL	5.972
95% BCA Bootstrap UCL	5.972	95% Bootstrap t UCL	6.11
95% H-UCL (Log ROS)	6.307		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	1.582	95% H-UCL (KM -Log)	6.203
KM SD (logged)	0.374	95% Critical H Value (KM-Log)	1.909
KM Standard Error of Mean (logged)	0.0917		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	4.794	Mean in Log Scale	1.389
SD in Original Scale	2.509	SD in Log Scale	0.669
95% t UCL (Assumes normality)	5.823	95% H-Stat UCL	7.171

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	6.026	95% KM (Percentile Bootstrap) UCL	5.917

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic

General Statistics

Total Number of Observations	18	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	1.53	Mean	6.423
Maximum	10.6	Median	6.765
SD	2.597	Std. Error of Mean	0.612
Coefficient of Variation	0.404	Skewness	-0.546

Normal GOF Test

Shapiro Wilk Test Statistic	0.937	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.897	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.152	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.209	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	7.488	95% Adjusted-CLT UCL (Chen-1995)	7.346
		95% Modified-t UCL (Johnson-1978)	7.475

Gamma GOF Test

A-D Test Statistic	0.918	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.743	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.207	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.204	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.559	k star (bias corrected MLE)	3.836
Theta hat (MLE)	1.409	Theta star (bias corrected MLE)	1.674
nu hat (MLE)	164.1	nu star (bias corrected)	138.1
MLE Mean (bias corrected)	6.423	MLE Sd (bias corrected)	3.279
		Approximate Chi Square Value (0.05)	111.9
Adjusted Level of Significance	0.0357	Adjusted Chi Square Value	109.7

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	7.923	95% Adjusted Gamma UCL (use when n<50)	8.086

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.842	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.897	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.222	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.209	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.425	Mean of logged Data	1.746
Maximum of Logged Data	2.361	SD of logged Data	0.547

Assuming Lognormal Distribution

95% H-UCL	8.763	90% Chebyshev (MVUE) UCL	9.254
95% Chebyshev (MVUE) UCL	10.46	97.5% Chebyshev (MVUE) UCL	12.13
99% Chebyshev (MVUE) UCL	15.41		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	7.43	95% Jackknife UCL	7.488
95% Standard Bootstrap UCL	7.389	95% Bootstrap-t UCL	7.414
95% Hall's Bootstrap UCL	7.328	95% Percentile Bootstrap UCL	7.394
95% BCA Bootstrap UCL	7.363		
90% Chebyshev(Mean, Sd) UCL	8.259	95% Chebyshev(Mean, Sd) UCL	9.091
97.5% Chebyshev(Mean, Sd) UCL	10.25	99% Chebyshev(Mean, Sd) UCL	12.51

Suggested UCL to Use

95% Student's-t UCL	7.488

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Boron

General Statistics

Total Number of Observations	18	Number of Distinct Observations	15
		Number of Missing Observations	0
Minimum	4.4	Mean	8.383
Maximum	17.4	Median	7.05

SD	3.881	Std. Error of Mean	0.915
Coefficient of Variation	0.463	Skewness	1.29

Normal GOF Test

Shapiro Wilk Test Statistic	0.841	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.897	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.226	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.209	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	9.975	95% Adjusted-CLT UCL (Chen-1995)	10.19
		95% Modified-t UCL (Johnson-1978)	10.02

Gamma GOF Test

A-D Test Statistic	0.68	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.742	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.171	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.204	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.95	k star (bias corrected MLE)	4.995
Theta hat (MLE)	1.409	Theta star (bias corrected MLE)	1.678
nu hat (MLE)	214.2	nu star (bias corrected)	179.8
MLE Mean (bias corrected)	8.383	MLE Sd (bias corrected)	3.751
		Approximate Chi Square Value (0.05)	149.8
Adjusted Level of Significance	0.0357	Adjusted Chi Square Value	147.2

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	10.06	95% Adjusted Gamma UCL (use when n<50)	10.24

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.93	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.897	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.143	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.209	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.482	Mean of logged Data	2.04
Maximum of Logged Data	2.856	SD of logged Data	0.413

Assuming Lognormal Distribution

95% H-UCL	10.17	90% Chebyshev (MVUE) UCL	10.82
95% Chebyshev (MVUE) UCL	11.95	97.5% Chebyshev (MVUE) UCL	13.52
99% Chebyshev (MVUE) UCL	16.6		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	9.888	95% Jackknife UCL	9.975
95% Standard Bootstrap UCL	9.861	95% Bootstrap-t UCL	10.56
95% Hall's Bootstrap UCL	10.33	95% Percentile Bootstrap UCL	9.881
95% BCA Bootstrap UCL	10.09		
90% Chebyshev(Mean, Sd) UCL	11.13	95% Chebyshev(Mean, Sd) UCL	12.37
97.5% Chebyshev(Mean, Sd) UCL	14.1	99% Chebyshev(Mean, Sd) UCL	17.49

Suggested UCL to Use

95% Adjusted Gamma UCL 10.24

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Cadmium

General Statistics

Total Number of Observations	39	Number of Distinct Observations	37
		Number of Missing Observations	0
Minimum	0.481	Mean	13.21
Maximum	104	Median	4.48
SD	19.88	Std. Error of Mean	3.183
Coefficient of Variation	1.504	Skewness	2.953

Normal GOF Test

Shapiro Wilk Test Statistic	0.659	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.939	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.261	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.142	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	18.58	95% Adjusted-CLT UCL (Chen-1995)	20.05
		95% Modified-t UCL (Johnson-1978)	18.83

Gamma GOF Test

A-D Test Statistic	1.296	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.801	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.178	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.148	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.625	k star (bias corrected MLE)	0.594
Theta hat (MLE)	21.15	Theta star (bias corrected MLE)	22.25
nu hat (MLE)	48.73	nu star (bias corrected)	46.31
MLE Mean (bias corrected)	13.21	MLE Sd (bias corrected)	17.15
		Approximate Chi Square Value (0.05)	31.7
Adjusted Level of Significance	0.0437	Adjusted Chi Square Value	31.22

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	19.3	95% Adjusted Gamma UCL (use when n<50)	19.6

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.931	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.939	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.146	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.142	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.732	Mean of logged Data	1.598
Maximum of Logged Data	4.644	SD of logged Data	1.496

Assuming Lognormal Distribution

95% H-UCL	31.6	90% Chebyshev (MVUE) UCL	27.63
95% Chebyshev (MVUE) UCL	33.67	97.5% Chebyshev (MVUE) UCL	42.05
99% Chebyshev (MVUE) UCL	58.52		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	18.45	95% Jackknife UCL	18.58
95% Standard Bootstrap UCL	18.37	95% Bootstrap-t UCL	22.1
95% Hall's Bootstrap UCL	27.03	95% Percentile Bootstrap UCL	18.54
95% BCA Bootstrap UCL	20.49		
90% Chebyshev(Mean, Sd) UCL	22.76	95% Chebyshev(Mean, Sd) UCL	27.08
97.5% Chebyshev(Mean, Sd) UCL	33.09	99% Chebyshev(Mean, Sd) UCL	44.88

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	27.08

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Chromium

General Statistics

Total Number of Observations	39	Number of Distinct Observations	38
		Number of Missing Observations	0
Minimum	10.7	Mean	96.95
Maximum	1030	Median	47.65
SD	172.5	Std. Error of Mean	27.63
Coefficient of Variation	1.78	Skewness	4.501

Normal GOF Test

Shapiro Wilk Test Statistic	0.481	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.939	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.309	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.142	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	143.5	95% Adjusted-CLT UCL (Chen-1995)	163.7
		95% Modified-t UCL (Johnson-1978)	146.9

Gamma GOF Test

A-D Test Statistic	2.231	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.782	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.18	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.146	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.903	k star (bias corrected MLE)	0.851
Theta hat (MLE)	107.3	Theta star (bias corrected MLE)	114
nu hat (MLE)	70.45	nu star (bias corrected)	66.36
MLE Mean (bias corrected)	96.95	MLE Sd (bias corrected)	105.1
		Approximate Chi Square Value (0.05)	48.61
Adjusted Level of Significance	0.0437	Adjusted Chi Square Value	48.01

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	132.3	95% Adjusted Gamma UCL (use when n<50)	134

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.932	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.939	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.151	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.142	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.37	Mean of logged Data	3.927
Maximum of Logged Data	6.937	SD of logged Data	1.017

Assuming Lognormal Distribution

95% H-UCL	126.9	90% Chebyshev (MVUE) UCL	131.2
95% Chebyshev (MVUE) UCL	152.8	97.5% Chebyshev (MVUE) UCL	182.7
99% Chebyshev (MVUE) UCL	241.6		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	142.4	95% Jackknife UCL	143.5
95% Standard Bootstrap UCL	141.4	95% Bootstrap-t UCL	211.6
95% Hall's Bootstrap UCL	306.8	95% Percentile Bootstrap UCL	145.7
95% BCA Bootstrap UCL	171.5		
90% Chebyshev(Mean, Sd) UCL	179.8	95% Chebyshev(Mean, Sd) UCL	217.4
97.5% Chebyshev(Mean, Sd) UCL	269.5	99% Chebyshev(Mean, Sd) UCL	371.9

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	217.4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Cobalt

General Statistics

Total Number of Observations	18	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	2.77	Mean	6.489
Maximum	10.6	Median	5.793
SD	2.365	Std. Error of Mean	0.557
Coefficient of Variation	0.364	Skewness	0.192

Normal GOF Test

Shapiro Wilk Test Statistic	0.947	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.897	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.166	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.209	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	7.459	95% Adjusted-CLT UCL (Chen-1995)	7.433
		95% Modified-t UCL (Johnson-1978)	7.463

Gamma GOF Test

A-D Test Statistic	0.367	**Anderson-Darling Gamma GOF Test**

5% A-D Critical Value	0.741	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.182	**Kolmogrov-Smirnoff Gamma GOF Test**	
5% K-S Critical Value	0.204	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.497	k star (bias corrected MLE)	6.284
Theta hat (MLE)	0.866	Theta star (bias corrected MLE)	1.033
nu hat (MLE)	269.9	nu star (bias corrected)	226.2
MLE Mean (bias corrected)	6.489	MLE Sd (bias corrected)	2.588
		Approximate Chi Square Value (0.05)	192.4
Adjusted Level of Significance	0.0357	Adjusted Chi Square Value	189.4

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	7.629	95% Adjusted Gamma UCL (use when n<50)	7.75

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.952	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.897	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.178	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.209	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.019	Mean of logged Data	1.802
Maximum of Logged Data	2.361	SD of logged Data	0.39

Assuming Lognormal Distribution

95% H-UCL	7.845	90% Chebyshev (MVUE) UCL	8.346
95% Chebyshev (MVUE) UCL	9.177	97.5% Chebyshev (MVUE) UCL	10.33
99% Chebyshev (MVUE) UCL	12.6		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	7.406	95% Jackknife UCL	7.459
95% Standard Bootstrap UCL	7.387	95% Bootstrap-t UCL	7.477
95% Hall's Bootstrap UCL	7.41	95% Percentile Bootstrap UCL	7.414
95% BCA Bootstrap UCL	7.34		
90% Chebyshev(Mean, Sd) UCL	8.161	95% Chebyshev(Mean, Sd) UCL	8.919
97.5% Chebyshev(Mean, Sd) UCL	9.97	99% Chebyshev(Mean, Sd) UCL	12.04

Suggested UCL to Use

95% Student's-t UCL	7.459

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.

For additional insight the user may want to consult a statistician.

Copper

General Statistics

Total Number of Observations	18	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	10.6	Mean	35.42
Maximum	68.8	Median	33.85
SD	14.91	Std. Error of Mean	3.514
Coefficient of Variation	0.421	Skewness	0.381

Normal GOF Test

Shapiro Wilk Test Statistic	0.972	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.897	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.124	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.209	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	41.53	95% Adjusted-CLT UCL (Chen-1995)	41.54
		95% Modified-t UCL (Johnson-1978)	41.59

Gamma GOF Test

A-D Test Statistic	0.356	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.743	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.168	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.204	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.214	k star (bias corrected MLE)	4.382
Theta hat (MLE)	6.793	Theta star (bias corrected MLE)	8.082
nu hat (MLE)	187.7	nu star (bias corrected)	157.8
MLE Mean (bias corrected)	35.42	MLE Sd (bias corrected)	16.92
		Approximate Chi Square Value (0.05)	129.7
Adjusted Level of Significance	0.0357	Adjusted Chi Square Value	127.3

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	43.07	95% Adjusted Gamma UCL (use when n<50)	43.9

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.927	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.897	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.201	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.209	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.361	Mean of logged Data	3.468
Maximum of Logged Data	4.231	SD of logged Data	0.488

Assuming Lognormal Distribution

95% H-UCL	45.85	90% Chebyshev (MVUE) UCL	48.67
95% Chebyshev (MVUE) UCL	54.46	97.5% Chebyshev (MVUE) UCL	62.5
99% Chebyshev (MVUE) UCL	78.3		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	41.2	95% Jackknife UCL	41.53
95% Standard Bootstrap UCL	41.19	95% Bootstrap-t UCL	41.78
95% Hall's Bootstrap UCL	42.5	95% Percentile Bootstrap UCL	41.27
95% BCA Bootstrap UCL	41.69		
90% Chebyshev(Mean, Sd) UCL	45.96	95% Chebyshev(Mean, Sd) UCL	50.74
97.5% Chebyshev(Mean, Sd) UCL	57.36	99% Chebyshev(Mean, Sd) UCL	70.38

Suggested UCL to Use

95% Student's-t UCL	41.53

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Manganese

General Statistics

Total Number of Observations	18	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	119	Mean	766.2
Maximum	2580	Median	543
SD	675.6	Std. Error of Mean	159.2
Coefficient of Variation	0.882	Skewness	1.571

Normal GOF Test

Shapiro Wilk Test Statistic	0.803	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.897	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.242	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.209	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL | **95% UCLs (Adjusted for Skewness)**

95% Student's-t UCL	1043	95% Adjusted-CLT UCL (Chen-1995)	1091
		95% Modified-t UCL (Johnson-1978)	1053

Gamma GOF Test

A-D Test Statistic	0.5	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.755	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.145	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.207	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.702	k star (bias corrected MLE)	1.456
Theta hat (MLE)	450.1	Theta star (bias corrected MLE)	526.3
nu hat (MLE)	61.29	nu star (bias corrected)	52.41
MLE Mean (bias corrected)	766.2	MLE Sd (bias corrected)	635.1
		Approximate Chi Square Value (0.05)	36.78
Adjusted Level of Significance	0.0357	Adjusted Chi Square Value	35.52

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	1092	95% Adjusted Gamma UCL (use when n<50)	1130

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.976	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.897	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.113	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.209	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.779	Mean of logged Data	6.32
Maximum of Logged Data	7.856	SD of logged Data	0.821

Assuming Lognormal Distribution

95% H-UCL	1251	90% Chebyshev (MVUE) UCL	1236
95% Chebyshev (MVUE) UCL	1452	97.5% Chebyshev (MVUE) UCL	1752
99% Chebyshev (MVUE) UCL	2340		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1028	95% Jackknife UCL	1043
95% Standard Bootstrap UCL	1021	95% Bootstrap-t UCL	1183
95% Hall's Bootstrap UCL	1101	95% Percentile Bootstrap UCL	1016
95% BCA Bootstrap UCL	1090		
90% Chebyshev(Mean, Sd) UCL	1244	95% Chebyshev(Mean, Sd) UCL	1460
97.5% Chebyshev(Mean, Sd) UCL	1761	99% Chebyshev(Mean, Sd) UCL	2351

Suggested UCL to Use

95% Adjusted Gamma UCL	1130

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Mercury

General Statistics

Total Number of Observations	18	Number of Distinct Observations	14
		Number of Missing Observations	0
Minimum	0.02	Mean	0.0876
Maximum	0.236	Median	0.103
SD	0.0556	Std. Error of Mean	0.0131
Coefficient of Variation	0.634	Skewness	0.797

Normal GOF Test

Shapiro Wilk Test Statistic	0.878	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.897	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.167	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.209	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.11	95% Adjusted-CLT UCL (Chen-1995)	0.112
		95% Modified-t UCL (Johnson-1978)	0.111

Gamma GOF Test

A-D Test Statistic	1.05	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.751	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.215	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.206	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.19	k star (bias corrected MLE)	1.862
Theta hat (MLE)	0.04	Theta star (bias corrected MLE)	0.047
nu hat (MLE)	78.84	nu star (bias corrected)	67.03
MLE Mean (bias corrected)	0.0876	MLE Sd (bias corrected)	0.0642
		Approximate Chi Square Value (0.05)	49.19
Adjusted Level of Significance	0.0357	Adjusted Chi Square Value	47.72

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.119	95% Adjusted Gamma UCL (use when n<50)	0.123

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.845	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.897	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.235	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.209	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-3.912	Mean of logged Data	-2.681
Maximum of Logged Data	-1.444	SD of logged Data	0.789

Assuming Lognormal Distribution

95% H-UCL	0.147	90% Chebyshev (MVUE) UCL	0.147
95% Chebyshev (MVUE) UCL	0.172	97.5% Chebyshev (MVUE) UCL	0.206
99% Chebyshev (MVUE) UCL	0.274		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.109	95% Jackknife UCL	0.11
95% Standard Bootstrap UCL	0.108	95% Bootstrap-t UCL	0.113
95% Hall's Bootstrap UCL	0.118	95% Percentile Bootstrap UCL	0.11
95% BCA Bootstrap UCL	0.111		
90% Chebyshev(Mean, Sd) UCL	0.127	95% Chebyshev(Mean, Sd) UCL	0.145
97.5% Chebyshev(Mean, Sd) UCL	0.169	99% Chebyshev(Mean, Sd) UCL	0.218

Suggested UCL to Use

95% Student's-t UCL	0.11

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Molybdenum

General Statistics

Total Number of Observations	18	Number of Distinct Observations	12
Number of Detects	12	Number of Non-Detects	6
Number of Distinct Detects	11	Number of Distinct Non-Detects	1
Minimum Detect	2.2	Minimum Non-Detect	0.5
Maximum Detect	10.8	Maximum Non-Detect	0.5
Variance Detects	5.162	Percent Non-Detects	33.33%
Mean Detects	4.567	SD Detects	2.272
Median Detects	4.45	CV Detects	0.498
Skewness Detects	1.961	Kurtosis Detects	5.296
Mean of Logged Detects	1.426	SD of Logged Detects	0.435

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.788	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.859	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.29	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.256	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	3.211	Standard Error of Mean	0.643
SD	2.613	95% KM (BCA) UCL	4.228
95% KM (t) UCL	4.33	95% KM (Percentile Bootstrap) UCL	4.289
95% KM (z) UCL	4.269	95% KM Bootstrap t UCL	4.478
90% KM Chebyshev UCL	5.141	95% KM Chebyshev UCL	6.016
97.5% KM Chebyshev UCL	7.229	99% KM Chebyshev UCL	9.613

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.509	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.732	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.225	**Kolmogrov-Smirnoff GOF**	
5% K-S Critical Value	0.246	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	5.578	k star (bias corrected MLE)	4.239
Theta hat (MLE)	0.819	Theta star (bias corrected MLE)	1.077
nu hat (MLE)	133.9	nu star (bias corrected)	101.7
MLE Mean (bias corrected)	4.567	MLE Sd (bias corrected)	2.218

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	1.51	nu hat (KM)	54.35
Approximate Chi Square Value (54.35, α)	38.41	Adjusted Chi Square Value (54.35, β)	37.13
95% Gamma Approximate KM-UCL (use when n>=50)	4.544	95% Gamma Adjusted KM-UCL (use when n<50)	4.701

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	3.214
Maximum	10.8	Median	2.95
SD	2.702	CV	0.841
k hat (MLE)	0.715	k star (bias corrected MLE)	0.633
Theta hat (MLE)	4.493	Theta star (bias corrected MLE)	5.076
nu hat (MLE)	25.75	nu star (bias corrected)	22.79
MLE Mean (bias corrected)	3.214	MLE Sd (bias corrected)	4.039
		Adjusted Level of Significance (β)	0.0357
Approximate Chi Square Value (22.79, α)	12.93	Adjusted Chi Square Value (22.79, β)	12.22
95% Gamma Approximate UCL (use when n>=50)	5.663	95% Gamma Adjusted UCL (use when n<50)	5.992

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.926	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.859	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.206	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.256	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	3.534	Mean in Log Scale	1.069
SD in Original Scale	2.375	SD in Log Scale	0.646
95% t UCL (assumes normality of ROS data)	4.508	95% Percentile Bootstrap UCL	4.492
95% BCA Bootstrap UCL	4.716	95% Bootstrap t UCL	4.841
95% H-UCL (Log ROS)	5.042		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	0.72	95% H-UCL (KM -Log)	7.193
KM SD (logged)	1.055	95% Critical H Value (KM-Log)	2.719
KM Standard Error of Mean (logged)	0.26		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	3.128	Mean in Log Scale	0.489
SD in Original Scale	2.779	SD in Log Scale	1.409
95% t UCL (Assumes normality)	4.267	95% H-Stat UCL	13.48

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (Percentile Bootstrap) UCL	4.289	95% GROS Adjusted Gamma UCL	5.992
95% Adjusted Gamma KM-UCL	4.701		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel

General Statistics

Total Number of Observations	40	Number of Distinct Observations	38
		Number of Missing Observations	0
Minimum	8.6	Mean	78.84
Maximum	1110	Median	30.3
SD	173.8	Std. Error of Mean	27.49
Coefficient of Variation	2.205	Skewness	5.615

Normal GOF Test

Shapiro Wilk Test Statistic	0.368	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.94	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.343	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.14	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	125.2	95% Adjusted-CLT UCL (Chen-1995)	150.1
		95% Modified-t UCL (Johnson-1978)	129.2

Gamma GOF Test

A-D Test Statistic	2.396	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.788	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.194	**Kolmogrov-Smirnoff Gamma GOF Test**	
5% K-S Critical Value	0.145	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.786	k star (bias corrected MLE)	0.744
Theta hat (MLE)	100.3	Theta star (bias corrected MLE)	106
nu hat (MLE)	62.87	nu star (bias corrected)	59.49
MLE Mean (bias corrected)	78.84	MLE Sd (bias corrected)	91.43
		Approximate Chi Square Value (0.05)	42.75
Adjusted Level of Significance	0.044	Adjusted Chi Square Value	42.22

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	109.7	95% Adjusted Gamma UCL (use when n<50)	111.1

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.892	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.94	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.183	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.14	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.152	Mean of logged Data	3.61
Maximum of Logged Data	7.012	SD of logged Data	1.095

Assuming Lognormal Distribution

95% H-UCL	104.8	90% Chebyshev (MVUE) UCL	106.5
95% Chebyshev (MVUE) UCL	125	97.5% Chebyshev (MVUE) UCL	150.6
99% Chebyshev (MVUE) UCL	200.9		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	124.1	95% Jackknife UCL	125.2
95% Standard Bootstrap UCL	123.4	95% Bootstrap-t UCL	221.2
95% Hall's Bootstrap UCL	293.6	95% Percentile Bootstrap UCL	130.1
95% BCA Bootstrap UCL	162.1		
90% Chebyshev(Mean, Sd) UCL	161.3	95% Chebyshev(Mean, Sd) UCL	198.6
97.5% Chebyshev(Mean, Sd) UCL	250.5	99% Chebyshev(Mean, Sd) UCL	352.3

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL 198.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Selenium

General Statistics

Total Number of Observations	40	Number of Distinct Observations	31
Number of Detects	35	Number of Non-Detects	5
Number of Distinct Detects	30	Number of Distinct Non-Detects	2
Minimum Detect	0.5	Minimum Non-Detect	0.5
Maximum Detect	148	Maximum Non-Detect	0.6
Variance Detects	1034	Percent Non-Detects	12.5%
Mean Detects	21.97	SD Detects	32.15
Median Detects	9.7	CV Detects	1.464
Skewness Detects	2.407	Kurtosis Detects	6.629
Mean of Logged Detects	1.965	SD of Logged Detects	1.668

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.696	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.934	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.252	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.15	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	19.28	Standard Error of Mean	4.89
SD	30.48	95% KM (BCA) UCL	28.38
95% KM (t) UCL	27.52	95% KM (Percentile Bootstrap) UCL	27.8
95% KM (z) UCL	27.33	95% KM Bootstrap t UCL	32.06
90% KM Chebyshev UCL	33.95	95% KM Chebyshev UCL	40.6
97.5% KM Chebyshev UCL	49.82	99% KM Chebyshev UCL	67.94

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.229	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.807	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.218	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.157	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.556	k star (bias corrected MLE)	0.527
Theta hat (MLE)	39.52	Theta star (bias corrected MLE)	41.66
nu hat (MLE)	38.91	nu star (bias corrected)	36.9
MLE Mean (bias corrected)	21.97	MLE Sd (bias corrected)	30.25

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.4	nu hat (KM)	32.01
Approximate Chi Square Value (32.01, α)	20.08	Adjusted Chi Square Value (32.01, β)	19.73
95% Gamma Approximate KM-UCL (use when n>=50)	30.74	95% Gamma Adjusted KM-UCL (use when n<50)	31.29

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	19.22
Maximum	148	Median	3.2
SD	30.91	CV	1.608
k hat (MLE)	0.368	k star (bias corrected MLE)	0.357
Theta hat (MLE)	52.23	Theta star (bias corrected MLE)	53.83
nu hat (MLE)	29.44	nu star (bias corrected)	28.57
MLE Mean (bias corrected)	19.22	MLE Sd (bias corrected)	32.17
		Adjusted Level of Significance (β)	0.044
Approximate Chi Square Value (28.57, α)	17.37	Adjusted Chi Square Value (28.57, β)	17.04
95% Gamma Approximate UCL (use when n>=50)	31.61	95% Gamma Adjusted UCL (use when n<50)	32.22

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.91	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.934	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.206	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.15	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	19.24	Mean in Log Scale	1.504
SD in Original Scale	30.89	SD in Log Scale	1.995
95% t UCL (assumes normality of ROS data)	27.47	95% Percentile Bootstrap UCL	27.48
95% BCA Bootstrap UCL	30.02	95% Bootstrap t UCL	30.94
95% H-UCL (Log ROS)	109.7		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	19.25	Mean in Log Scale	1.56
SD in Original Scale	30.89	SD in Log Scale	1.899
95% t UCL (Assumes normality)	27.48	95% H-Stat UCL	86.79

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

97.5% KM (Chebyshev) UCL	49.82

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Silver

General Statistics

Total Number of Observations	18	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	0.117	Mean	0.716
Maximum	2.16	Median	0.678
SD	0.566	Std. Error of Mean	0.134
Coefficient of Variation	0.791	Skewness	1.365

Normal GOF Test

Shapiro Wilk Test Statistic	0.843	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.897	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.23	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.209	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.948	95% Adjusted-CLT UCL (Chen-1995)	0.981
		95% Modified-t UCL (Johnson-1978)	0.955

Gamma GOF Test

A-D Test Statistic	0.562	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.755	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.153	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.207	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.661	k star (bias corrected MLE)	1.421
Theta hat (MLE)	0.431	Theta star (bias corrected MLE)	0.504
nu hat (MLE)	59.79	nu star (bias corrected)	51.16
MLE Mean (bias corrected)	0.716	MLE Sd (bias corrected)	0.6
		Approximate Chi Square Value (0.05)	35.73
Adjusted Level of Significance	0.0357	Adjusted Chi Square Value	34.5

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	1.025	95% Adjusted Gamma UCL (use when n<50)	1.062

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.907	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.897	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.155	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.209	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-2.146	Mean of logged Data	-0.665
Maximum of Logged Data	0.77	SD of logged Data	0.901

Assuming Lognormal Distribution

95% H-UCL	1.332	90% Chebyshev (MVUE) UCL	1.271
95% Chebyshev (MVUE) UCL	1.507	97.5% Chebyshev (MVUE) UCL	1.836
99% Chebyshev (MVUE) UCL	2.48		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.935	95% Jackknife UCL	0.948
95% Standard Bootstrap UCL	0.924	95% Bootstrap-t UCL	1.032
95% Hall's Bootstrap UCL	1.273	95% Percentile Bootstrap UCL	0.933
95% BCA Bootstrap UCL	0.985		
90% Chebyshev(Mean, Sd) UCL	1.116	95% Chebyshev(Mean, Sd) UCL	1.298
97.5% Chebyshev(Mean, Sd) UCL	1.55	99% Chebyshev(Mean, Sd) UCL	2.044

Suggested UCL to Use

95% Adjusted Gamma UCL	1.062

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Thallium

General Statistics

Total Number of Observations	18	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	0.121	Mean	0.879
Maximum	2.17	Median	0.912
SD	0.575	Std. Error of Mean	0.135
Coefficient of Variation	0.654	Skewness	0.399

Normal GOF Test

Shapiro Wilk Test Statistic	0.947	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.897	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.114	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.209	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1.115	95% Adjusted-CLT UCL (Chen-1995)	1.115
		95% Modified-t UCL (Johnson-1978)	1.117

Gamma GOF Test

A-D Test Statistic	0.549	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.754	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.165	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.207	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.835	k star (bias corrected MLE)	1.566
Theta hat (MLE)	0.479	Theta star (bias corrected MLE)	0.561
nu hat (MLE)	66.05	nu star (bias corrected)	56.37
MLE Mean (bias corrected)	0.879	MLE Sd (bias corrected)	0.702
		Approximate Chi Square Value (0.05)	40.11
Adjusted Level of Significance	0.0357	Adjusted Chi Square Value	38.8

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.235	95% Adjusted Gamma UCL (use when n<50)	1.277

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.894	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.897	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.177	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.209	Data appear Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-2.112	Mean of logged Data	-0.426
Maximum of Logged Data	0.775	SD of logged Data	0.896

Assuming Lognormal Distribution

95% H-UCL	1.678	90% Chebyshev (MVUE) UCL	1.605
95% Chebyshev (MVUE) UCL	1.902	97.5% Chebyshev (MVUE) UCL	2.315
99% Chebyshev (MVUE) UCL	3.126		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.102	95% Jackknife UCL	1.115
95% Standard Bootstrap UCL	1.099	95% Bootstrap-t UCL	1.124
95% Hall's Bootstrap UCL	1.134	95% Percentile Bootstrap UCL	1.106
95% BCA Bootstrap UCL	1.112		
90% Chebyshev(Mean, Sd) UCL	1.285	95% Chebyshev(Mean, Sd) UCL	1.469
97.5% Chebyshev(Mean, Sd) UCL	1.725	99% Chebyshev(Mean, Sd) UCL	2.227

Suggested UCL to Use

95% Student's-t UCL	1.115

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Uranium

General Statistics

Total Number of Observations	18	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	1.65	Mean	17.71
Maximum	90	Median	9.935
SD	23.08	Std. Error of Mean	5.439
Coefficient of Variation	1.303	Skewness	2.382

Normal GOF Test

Shapiro Wilk Test Statistic	0.679	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.897	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.285	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.209	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	27.17	95% Adjusted-CLT UCL (Chen-1995)	29.92
		95% Modified-t UCL (Johnson-1978)	27.68

Gamma GOF Test

A-D Test Statistic	0.511	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.771	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.148	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.21	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.911	k star (bias corrected MLE)	0.797

Theta hat (MLE)	19.43	Theta star (bias corrected MLE)	22.23
nu hat (MLE)	32.81	nu star (bias corrected)	28.67
MLE Mean (bias corrected)	17.71	MLE Sd (bias corrected)	19.84
		Approximate Chi Square Value (0.05)	17.45
Adjusted Level of Significance	0.0357	Adjusted Chi Square Value	16.62

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	29.09	95% Adjusted Gamma UCL (use when n<50)	30.56

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.951	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.897	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.125	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.209	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.501	Mean of logged Data	2.234
Maximum of Logged Data	4.5	SD of logged Data	1.183

Assuming Lognormal Distribution

95% H-UCL	43.39	90% Chebyshev (MVUE) UCL	34.54
95% Chebyshev (MVUE) UCL	42.17	97.5% Chebyshev (MVUE) UCL	52.76
99% Chebyshev (MVUE) UCL	73.57		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	26.66	95% Jackknife UCL	27.17
95% Standard Bootstrap UCL	26.29	95% Bootstrap-t UCL	40.94
95% Hall's Bootstrap UCL	72.29	95% Percentile Bootstrap UCL	27.3
95% BCA Bootstrap UCL	29.34		
90% Chebyshev(Mean, Sd) UCL	34.03	95% Chebyshev(Mean, Sd) UCL	41.42
97.5% Chebyshev(Mean, Sd) UCL	51.68	99% Chebyshev(Mean, Sd) UCL	71.83

Suggested UCL to Use

95% Adjusted Gamma UCL	30.56

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Vanadium

General Statistics

Total Number of Observations	40	Number of Distinct Observations	40

		Number of Missing Observations	0
Minimum	12.7	Mean	109.8
Maximum	940	Median	46.3
SD	175.5	Std. Error of Mean	27.75
Coefficient of Variation	1.599	Skewness	3.395

Normal GOF Test

Shapiro Wilk Test Statistic	0.559	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.94	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.318	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.14	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	156.5	95% Adjusted-CLT UCL (Chen-1995)	171.3
		95% Modified-t UCL (Johnson-1978)	159

Gamma GOF Test

A-D Test Statistic	2.123	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.784	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.175	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.144	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.881	k star (bias corrected MLE)	0.832
Theta hat (MLE)	124.6	Theta star (bias corrected MLE)	132
nu hat (MLE)	70.49	nu star (bias corrected)	66.54
MLE Mean (bias corrected)	109.8	MLE Sd (bias corrected)	120.4
		Approximate Chi Square Value (0.05)	48.77
Adjusted Level of Significance	0.044	Adjusted Chi Square Value	48.2

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	149.8	95% Adjusted Gamma UCL (use when n<50)	151.5

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.935	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.94	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.122	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.14	Data appear Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.542	Mean of logged Data	4.033
Maximum of Logged Data	6.846	SD of logged Data	1.064

Assuming Lognormal Distribution

95% H-UCL	151.7	90% Chebyshev (MVUE) UCL	155.4

95% Chebyshev (MVUE) UCL	181.7	97.5% Chebyshev (MVUE) UCL	218.2
99% Chebyshev (MVUE) UCL	289.9		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	155.4	95% Jackknife UCL	156.5
95% Standard Bootstrap UCL	154.3	95% Bootstrap-t UCL	195.5
95% Hall's Bootstrap UCL	195.7	95% Percentile Bootstrap UCL	158.5
95% BCA Bootstrap UCL	178.1		
90% Chebyshev(Mean, Sd) UCL	193	95% Chebyshev(Mean, Sd) UCL	230.7
97.5% Chebyshev(Mean, Sd) UCL	283.1	99% Chebyshev(Mean, Sd) UCL	385.9

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	230.7

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Zinc

General Statistics

Total Number of Observations	40	Number of Distinct Observations	38
		Number of Missing Observations	0
Minimum	42	Mean	518.5
Maximum	7940	Median	95
SD	1257	Std. Error of Mean	198.8
Coefficient of Variation	2.425	Skewness	5.543

Normal GOF Test

Shapiro Wilk Test Statistic	0.37	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.94	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.352	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.14	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	853.4	95% Adjusted-CLT UCL (Chen-1995)	1032
		95% Modified-t UCL (Johnson-1978)	882.4

Gamma GOF Test

A-D Test Statistic	2.781	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.801	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.245	**Kolmogrov-Smirnoff Gamma GOF Test**

5% K-S Critical Value	0.146	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.621	k star (bias corrected MLE)	0.592
Theta hat (MLE)	834.3	Theta star (bias corrected MLE)	876.6
nu hat (MLE)	49.72	nu star (bias corrected)	47.32
MLE Mean (bias corrected)	518.5	MLE Sd (bias corrected)	674.2
		Approximate Chi Square Value (0.05)	32.53
Adjusted Level of Significance	0.044	Adjusted Chi Square Value	32.07

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	754.2	95% Adjusted Gamma UCL (use when n<50)	765

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.879	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.94	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.23	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.14	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.738	Mean of logged Data	5.262
Maximum of Logged Data	8.98	SD of logged Data	1.277

Assuming Lognormal Distribution

95% H-UCL	764.8	90% Chebyshev (MVUE) UCL	737.4
95% Chebyshev (MVUE) UCL	880.7	97.5% Chebyshev (MVUE) UCL	1080
99% Chebyshev (MVUE) UCL	1471		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	845.5	95% Jackknife UCL	853.4
95% Standard Bootstrap UCL	842.1	95% Bootstrap-t UCL	1543
95% Hall's Bootstrap UCL	2030	95% Percentile Bootstrap UCL	901.3
95% BCA Bootstrap UCL	1155		
90% Chebyshev(Mean, Sd) UCL	1115	95% Chebyshev(Mean, Sd) UCL	1385
97.5% Chebyshev(Mean, Sd) UCL	1760	99% Chebyshev(Mean, Sd) UCL	2496

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	1385

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Henry Site Sediment

From Locations With Fish Present or Likely to be Present

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	5/24/2016 10:15:58 AM
From File	ProUCLinput-SE-fish present.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Antimony

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
Number of Detects	1	Number of Non-Detects	1
Number of Distinct Detects	1	Number of Distinct Non-Detects	1

Warning: This data set only has 2 observations!

Data set is too small to compute reliable and meaningful statistics and estimates!

The data set for variable Antimony was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!

If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Arsenic

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	0
Minimum	1.53	Mean	1.76
Maximum	1.99	Median	1.76

Warning: This data set only has 2 observations!

Data set is too small to compute reliable and meaningful statistics and estimates!

The data set for variable Arsenic was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!

If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Cadmium

General Statistics

Total Number of Observations	9	Number of Distinct Observations	9
		Number of Missing Observations	0
Minimum	0.66	Mean	1.121

Maximum	1.42	Median	1.19
SD	0.277	Std. Error of Mean	0.0923
Coefficient of Variation	0.247	Skewness	-0.38

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.894	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.184	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.295	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1.292	95% Adjusted-CLT UCL (Chen-1995)	1.26
		95% Modified-t UCL (Johnson-1978)	1.29

Gamma GOF Test

A-D Test Statistic	0.498	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.721	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.185	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.279	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	16.81	k star (bias corrected MLE)	11.28
Theta hat (MLE)	0.0667	Theta star (bias corrected MLE)	0.0994
nu hat (MLE)	302.5	nu star (bias corrected)	203
MLE Mean (bias corrected)	1.121	MLE Sd (bias corrected)	0.334
		Approximate Chi Square Value (0.05)	171.1
Adjusted Level of Significance	0.0231	Adjusted Chi Square Value	164.9

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.33	95% Adjusted Gamma UCL (use when n<50)	1.38

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.883	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.829	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.188	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.295	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.416	Mean of logged Data	0.0839
Maximum of Logged Data	0.351	SD of logged Data	0.267

Assuming Lognormal Distribution

95% H-UCL	1.358	90% Chebyshev (MVUE) UCL	1.424
95% Chebyshev (MVUE) UCL	1.56	97.5% Chebyshev (MVUE) UCL	1.75
99% Chebyshev (MVUE) UCL	2.122		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.272	95% Jackknife UCL	1.292
95% Standard Bootstrap UCL	1.264	95% Bootstrap-t UCL	1.275
95% Hall's Bootstrap UCL	1.252	95% Percentile Bootstrap UCL	1.26
95% BCA Bootstrap UCL	1.255		
90% Chebyshev(Mean, Sd) UCL	1.397	95% Chebyshev(Mean, Sd) UCL	1.523
97.5% Chebyshev(Mean, Sd) UCL	1.697	99% Chebyshev(Mean, Sd) UCL	2.039

Suggested UCL to Use

95% Student's-t UCL	1.292

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Chromium

General Statistics

Total Number of Observations	9	Number of Distinct Observations	9
		Number of Missing Observations	0
Minimum	17.5	Mean	25.24
Maximum	36	Median	24.8
SD	5.649	Std. Error of Mean	1.883
Coefficient of Variation	0.224	Skewness	0.359

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.932	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.829	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.171	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.295	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	28.75	95% Adjusted-CLT UCL (Chen-1995)	28.58
		95% Modified-t UCL (Johnson-1978)	28.78

Gamma GOF Test

A-D Test Statistic	0.373	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.721	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.182	**Kolmogrov-Smirnoff Gamma GOF Test**	
5% K-S Critical Value	0.279	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	22.25	k star (bias corrected MLE)	14.9
Theta hat (MLE)	1.135	Theta star (bias corrected MLE)	1.694
nu hat (MLE)	400.4	nu star (bias corrected)	268.3
MLE Mean (bias corrected)	25.24	MLE Sd (bias corrected)	6.539
		Approximate Chi Square Value (0.05)	231.3
Adjusted Level of Significance	0.0231	Adjusted Chi Square Value	224.1

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	29.27	95% Adjusted Gamma UCL (use when n<50)	30.22

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.926	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.829	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.2	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.295	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.862	Mean of logged Data	3.206
Maximum of Logged Data	3.584	SD of logged Data	0.228

Assuming Lognormal Distribution

95% H-UCL	29.59	90% Chebyshev (MVUE) UCL	31.02
95% Chebyshev (MVUE) UCL	33.63	97.5% Chebyshev (MVUE) UCL	37.26
99% Chebyshev (MVUE) UCL	44.38		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	28.34	95% Jackknife UCL	28.75
95% Standard Bootstrap UCL	28.23	95% Bootstrap-t UCL	29.1
95% Hall's Bootstrap UCL	29.48	95% Percentile Bootstrap UCL	28.08
95% BCA Bootstrap UCL	28.49		
90% Chebyshev(Mean, Sd) UCL	30.89	95% Chebyshev(Mean, Sd) UCL	33.45
97.5% Chebyshev(Mean, Sd) UCL	37	99% Chebyshev(Mean, Sd) UCL	43.98

Suggested UCL to Use

95% Student's-t UCL	28.75

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Cobalt

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	0
Minimum	5.36	Mean	5.455
Maximum	5.55	Median	5.455

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Cobalt was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Copper

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	0
Minimum	10.6	Mean	11.7
Maximum	12.8	Median	11.7

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Copper was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Manganese

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	0
Minimum	262	Mean	289
Maximum	316	Median	289

Warning: This data set only has 2 observations!

Data set is too small to compute reliable and meaningful statistics and estimates!

The data set for variable Manganese was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!

If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Nickel

General Statistics

Total Number of Observations	9	Number of Distinct Observations	8
		Number of Missing Observations	0
Minimum	11.3	Mean	13.57
Maximum	16.2	Median	14.4
SD	1.833	Std. Error of Mean	0.611
Coefficient of Variation	0.135	Skewness	-0.0356

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.

For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).

Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.881	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.233	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.295	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	14.7	95% Adjusted-CLT UCL (Chen-1995)	14.56
		95% Modified-t UCL (Johnson-1978)	14.7

Gamma GOF Test

A-D Test Statistic	0.628	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.72	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.251	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.279	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	60.94	k star (bias corrected MLE)	40.7
Theta hat (MLE)	0.223	Theta star (bias corrected MLE)	0.333
nu hat (MLE)	1097	nu star (bias corrected)	732.6
MLE Mean (bias corrected)	13.57	MLE Sd (bias corrected)	2.127
		Approximate Chi Square Value (0.05)	670.8
Adjusted Level of Significance	0.0231	Adjusted Chi Square Value	658.2

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	14.82	95% Adjusted Gamma UCL (use when n<50)	15.1

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.875	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.829	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.246	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.295	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.425	Mean of logged Data	2.599
Maximum of Logged Data	2.785	SD of logged Data	0.137

Assuming Lognormal Distribution

95% H-UCL	14.85	90% Chebyshev (MVUE) UCL	15.42
95% Chebyshev (MVUE) UCL	16.26	97.5% Chebyshev (MVUE) UCL	17.43
99% Chebyshev (MVUE) UCL	19.72		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	14.57	95% Jackknife UCL	14.7
95% Standard Bootstrap UCL	14.49	95% Bootstrap-t UCL	14.66
95% Hall's Bootstrap UCL	14.41	95% Percentile Bootstrap UCL	14.5
95% BCA Bootstrap UCL	14.51		
90% Chebyshev(Mean, Sd) UCL	15.4	95% Chebyshev(Mean, Sd) UCL	16.23
97.5% Chebyshev(Mean, Sd) UCL	17.38	99% Chebyshev(Mean, Sd) UCL	19.65

Suggested UCL to Use

95% Student's-t UCL	14.7

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Selenium

General Statistics

Total Number of Observations	9	Number of Distinct Observations	5
Number of Detects	7	Number of Non-Detects	2
Number of Distinct Detects	5	Number of Distinct Non-Detects	1
Minimum Detect	0.5	Minimum Non-Detect	0.5
Maximum Detect	1.67	Maximum Non-Detect	0.5
Variance Detects	0.137	Percent Non-Detects	22.22%
Mean Detects	1.206	SD Detects	0.37
Median Detects	1.3	CV Detects	0.307
Skewness Detects	-1.072	Kurtosis Detects	2.025
Mean of Logged Detects	0.131	SD of Logged Detects	0.393

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.918	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.245	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.335	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	1.049	Standard Error of Mean	0.152
SD	0.421	95% KM (BCA) UCL	1.268
95% KM (t) UCL	1.331	95% KM (Percentile Bootstrap) UCL	1.29
95% KM (z) UCL	1.298	95% KM Bootstrap t UCL	1.286
90% KM Chebyshev UCL	1.504	95% KM Chebyshev UCL	1.71
97.5% KM Chebyshev UCL	1.996	99% KM Chebyshev UCL	2.559

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.573	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.709	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.293	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.312	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	9.156	k star (bias corrected MLE)	5.327
Theta hat (MLE)	0.132	Theta star (bias corrected MLE)	0.226
nu hat (MLE)	128.2	nu star (bias corrected)	74.58
MLE Mean (bias corrected)	1.206	MLE Sd (bias corrected)	0.522

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	6.195	nu hat (KM)	111.5
Approximate Chi Square Value (111.51, α)	88.14	Adjusted Chi Square Value (111.51, β)	83.76
95% Gamma Approximate KM-UCL (use when n>=50)	1.327	95% Gamma Adjusted KM-UCL (use when n<50)	1.396

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.413	Mean	1.046
Maximum	1.67	Median	1.1
SD	0.453	CV	0.433
k hat (MLE)	4.9	k star (bias corrected MLE)	3.341
Theta hat (MLE)	0.213	Theta star (bias corrected MLE)	0.313
nu hat (MLE)	88.2	nu star (bias corrected)	60.13
MLE Mean (bias corrected)	1.046	MLE Sd (bias corrected)	0.572
		Adjusted Level of Significance (β)	0.0231
Approximate Chi Square Value (60.13, α)	43.3	Adjusted Chi Square Value (60.13, β)	40.3
95% Gamma Approximate UCL (use when n>=50)	1.452	95% Gamma Adjusted UCL (use when n<50)	1.56

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.804	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.32	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.335	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.048	Mean in Log Scale	-0.0552
SD in Original Scale	0.449	SD in Log Scale	0.506
95% t UCL (assumes normality of ROS data)	1.326	95% Percentile Bootstrap UCL	1.28
95% BCA Bootstrap UCL	1.266	95% Bootstrap t UCL	1.319
95% H-UCL (Log ROS)	1.604		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-0.0518	95% H-UCL (KM -Log)	1.528
KM SD (logged)	0.47	95% Critical H Value (KM-Log)	2.202
KM Standard Error of Mean (logged)	0.169		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.993	Mean in Log Scale	-0.206
SD in Original Scale	0.53	SD in Log Scale	0.751
95% t UCL (Assumes normality)	1.322	95% H-Stat UCL	2.219

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	1.331	95% KM (Percentile Bootstrap) UCL	1.29

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Thallium

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	0
Minimum	0.121	Mean	0.122
Maximum	0.122	Median	0.122

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Thallium was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Uranium

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	0
Minimum	1.65	Mean	1.965
Maximum	2.28	Median	1.965

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Uranium was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!

If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Vanadium

General Statistics

Total Number of Observations	9	Number of Distinct Observations	9
		Number of Missing Observations	0
Minimum	15.7	Mean	23.6
Maximum	34.3	Median	22.2
SD	6.708	Std. Error of Mean	2.236
Coefficient of Variation	0.284	Skewness	0.272

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use

guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.

For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).

Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.921	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.174	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.295	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	27.76	95% Adjusted-CLT UCL (Chen-1995)	27.49
		95% Modified-t UCL (Johnson-1978)	27.79

Gamma GOF Test

A-D Test Statistic	0.373	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.721	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.194	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.279	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	13.85	k star (bias corrected MLE)	9.31
Theta hat (MLE)	1.703	Theta star (bias corrected MLE)	2.535
nu hat (MLE)	249.4	nu star (bias corrected)	167.6
MLE Mean (bias corrected)	23.6	MLE Sd (bias corrected)	7.735
		Approximate Chi Square Value (0.05)	138.6
Adjusted Level of Significance	0.0231	Adjusted Chi Square Value	133.1

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	28.53	95% Adjusted Gamma UCL (use when n<50)	29.71

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.92	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.829	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.182	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.295	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.754	Mean of logged Data	3.125
Maximum of Logged Data	3.535	SD of logged Data	0.288

Assuming Lognormal Distribution

95% H-UCL	29.07	90% Chebyshev (MVUE) UCL	30.44
95% Chebyshev (MVUE) UCL	33.53	97.5% Chebyshev (MVUE) UCL	37.83
99% Chebyshev (MVUE) UCL	46.27		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	27.28	95% Jackknife UCL	27.76
95% Standard Bootstrap UCL	27.1	95% Bootstrap-t UCL	28.36
95% Hall's Bootstrap UCL	27.06	95% Percentile Bootstrap UCL	27.06
95% BCA Bootstrap UCL	27.07		
90% Chebyshev(Mean, Sd) UCL	30.31	95% Chebyshev(Mean, Sd) UCL	33.35
97.5% Chebyshev(Mean, Sd) UCL	37.56	99% Chebyshev(Mean, Sd) UCL	45.85

Suggested UCL to Use

95% Student's-t UCL	27.76

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Zinc

General Statistics

Total Number of Observations	9	Number of Distinct Observations	9
		Number of Missing Observations	0
Minimum	49	Mean	70.88
Maximum	92.7	Median	68
SD	14.07	Std. Error of Mean	4.691
Coefficient of Variation	0.199	Skewness	0.254

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.947	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.239	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.295	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	79.6	95% Adjusted-CLT UCL (Chen-1995)	79.02
		95% Modified-t UCL (Johnson-1978)	79.67

Gamma GOF Test

A-D Test Statistic	0.305	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.721	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.22	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.279	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	28.39	k star (bias corrected MLE)	19
Theta hat (MLE)	2.497	Theta star (bias corrected MLE)	3.73
nu hat (MLE)	511	nu star (bias corrected)	342
MLE Mean (bias corrected)	70.88	MLE Sd (bias corrected)	16.26
		Approximate Chi Square Value (0.05)	300.1
Adjusted Level of Significance	0.0231	Adjusted Chi Square Value	291.9

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	80.76	95% Adjusted Gamma UCL (use when n<50)	83.05

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.953	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.829	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.205	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.295	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.892	Mean of logged Data	4.243
Maximum of Logged Data	4.529	SD of logged Data	0.201

Assuming Lognormal Distribution

95% H-UCL	81.35	90% Chebyshev (MVUE) UCL	85.15
95% Chebyshev (MVUE) UCL	91.61	97.5% Chebyshev (MVUE) UCL	100.6
99% Chebyshev (MVUE) UCL	118.2		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	78.59	95% Jackknife UCL	79.6
95% Standard Bootstrap UCL	77.99	95% Bootstrap-t UCL	80.09
95% Hall's Bootstrap UCL	80.75	95% Percentile Bootstrap UCL	78.34
95% BCA Bootstrap UCL	78.38		
90% Chebyshev(Mean, Sd) UCL	84.95	95% Chebyshev(Mean, Sd) UCL	91.32
97.5% Chebyshev(Mean, Sd) UCL	100.2	99% Chebyshev(Mean, Sd) UCL	117.6

Suggested UCL to Use

95% Student's-t UCL	79.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Henry Site Groundwater

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	8/24/2015 1:52:53 PM
From File	ProUCLinput-GW.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Arsenic, Total

General Statistics

Total Number of Observations	12	Number of Distinct Observations	6
		Number of Missing Observations	88
Number of Detects	7	Number of Non-Detects	5
Number of Distinct Detects	5	Number of Distinct Non-Detects	2
Minimum Detect	5.0000E-4	Minimum Non-Detect	2.5000E-4
Maximum Detect	0.0043	Maximum Non-Detect	5.0000E-4
Variance Detects	3.3457E-6	Percent Non-Detects	41.67%
Mean Detects	0.00217	SD Detects	0.00183
Median Detects	0.0012	CV Detects	0.842
Skewness Detects	0.363	Kurtosis Detects	-2.59
Mean of Logged Detects	-6.523	SD of Logged Detects	0.997

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.767	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.274	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.335	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.00137	Standard Error of Mean	4.9988E-4
SD	0.0016	95% KM (BCA) UCL	0.00231
95% KM (t) UCL	0.00227	95% KM (Percentile Bootstrap) UCL	0.00226
95% KM (z) UCL	0.00219	95% KM Bootstrap t UCL	0.00235
90% KM Chebyshev UCL	0.00287	95% KM Chebyshev UCL	0.00355
97.5% KM Chebyshev UCL	0.00449	99% KM Chebyshev UCL	0.00634

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.751	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.722	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.262	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.317	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.424	k star (bias corrected MLE)	0.909
Theta hat (MLE)	0.00153	Theta star (bias corrected MLE)	0.00239

nu hat (MLE)	19.93	nu star (bias corrected)	12.72
MLE Mean (bias corrected)	0.00217	MLE Sd (bias corrected)	0.00228

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.731	nu hat (KM)	17.55
Approximate Chi Square Value (17.55, α)	9.065	Adjusted Chi Square Value (17.55, β)	8.15
95% Gamma Approximate KM-UCL (use when n>=50)	0.00265	95% Gamma Adjusted KM-UCL (use when n<50)	0.00295

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	5.0000E-4	Mean	0.00543
Maximum	0.01	Median	0.0043
SD	0.00425	CV	0.782
k hat (MLE)	1.12	k star (bias corrected MLE)	0.896
Theta hat (MLE)	0.00485	Theta star (bias corrected MLE)	0.00607
nu hat (MLE)	26.88	nu star (bias corrected)	21.5
MLE Mean (bias corrected)	0.00543	MLE Sd (bias corrected)	0.00574
		Adjusted Level of Significance (β)	0.029
Approximate Chi Square Value (21.50, α)	11.96	Adjusted Chi Square Value (21.50, β)	10.89
95% Gamma Approximate UCL (use when n>=50)	0.00976	95% Gamma Adjusted UCL (use when n<50)	0.0107

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.806	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.251	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.335	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00132	Mean in Log Scale	-7.61
SD in Original Scale	0.00171	SD in Log Scale	1.578
95% t UCL (assumes normality of ROS data)	0.00221	95% Percentile Bootstrap UCL	0.00218
95% BCA Bootstrap UCL	0.00225	95% Bootstrap t UCL	0.00246
95% H-UCL (Log ROS)	0.0119		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-7.261	95% H-UCL (KM -Log)	0.00382
KM SD (logged)	1.122	95% Critical H Value (KM-Log)	3.141
KM Standard Error of Mean (logged)	0.35		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00136	Mean in Log Scale	-7.319
SD in Original Scale	0.00168	SD in Log Scale	1.243
95% t UCL (Assumes normality)	0.00223	95% H-Stat UCL	0.00508

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.00227	95% KM (Percentile Bootstrap) UCL	0.00226

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chromium, Total

General Statistics

Total Number of Observations	26	Number of Distinct Observations	21
		Number of Missing Observations	80
Number of Detects	16	Number of Non-Detects	10
Number of Distinct Detects	16	Number of Distinct Non-Detects	5
Minimum Detect	4.0000E-4	Minimum Non-Detect	1.0000E-4
Maximum Detect	0.0038	Maximum Non-Detect	0.1
Variance Detects	6.9973E-7	Percent Non-Detects	38.46%
Mean Detects	0.00207	SD Detects	8.3650E-4
Median Detects	0.00216	CV Detects	0.403
Skewness Detects	0.00937	Kurtosis Detects	0.331
Mean of Logged Detects	-6.283	SD of Logged Detects	0.531

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.986	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.887	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.118	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.222	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.00144	Standard Error of Mean	2.3873E-4
SD	0.00112	95% KM (BCA) UCL	0.00185
95% KM (t) UCL	0.00185	95% KM (Percentile Bootstrap) UCL	0.00184
95% KM (z) UCL	0.00183	95% KM Bootstrap t UCL	0.00186
90% KM Chebyshev UCL	0.00216	95% KM Chebyshev UCL	0.00248
97.5% KM Chebyshev UCL	0.00293	99% KM Chebyshev UCL	0.00382

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.43	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.741	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.179	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.216	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	4.929	k star (bias corrected MLE)	4.046
Theta hat (MLE)	4.2076E-4	Theta star (bias corrected MLE)	5.1252E-4
nu hat (MLE)	157.7	nu star (bias corrected)	129.5
MLE Mean (bias corrected)	0.00207	MLE Sd (bias corrected)	0.00103

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	1.647	nu hat (KM)	85.64
Approximate Chi Square Value (85.64, α)	65.31	Adjusted Chi Square Value (85.64, β)	64.14
95% Gamma Approximate KM-UCL (use when n>=50)	0.00189	95% Gamma Adjusted KM-UCL (use when n<50)	0.00193

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	4.0000E-4	Mean	0.00512
Maximum	0.01	Median	0.00281
SD	0.00399	CV	0.778
k hat (MLE)	1.52	k star (bias corrected MLE)	1.37
Theta hat (MLE)	0.00337	Theta star (bias corrected MLE)	0.00374
nu hat (MLE)	79.04	nu star (bias corrected)	71.25
MLE Mean (bias corrected)	0.00512	MLE Sd (bias corrected)	0.00438
		Adjusted Level of Significance (β)	0.0398
Approximate Chi Square Value (71.25, α)	52.82	Adjusted Chi Square Value (71.25, β)	51.77
95% Gamma Approximate UCL (use when n>=50)	0.00691	95% Gamma Adjusted UCL (use when n<50)	0.00705

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.865	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.887	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.198	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.222	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00158	Mean in Log Scale	-6.64
SD in Original Scale	9.3358E-4	SD in Log Scale	0.66
95% t UCL (assumes normality of ROS data)	0.0019	95% Percentile Bootstrap UCL	0.0019
95% BCA Bootstrap UCL	0.00188	95% Bootstrap t UCL	0.00192
95% H-UCL (Log ROS)	0.00215		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-7.192	95% H-UCL (KM -Log)	0.00473
KM SD (logged)	1.4	95% Critical H Value (KM-Log)	3.065
KM Standard Error of Mean (logged)	0.303		

DL/2 Statistics

DL/2 Normal **DL/2 Log-Transformed**

Mean in Original Scale	0.00519	Mean in Log Scale	-6.879
SD in Original Scale	0.0132	SD in Log Scale	1.856
95% t UCL (Assumes normality)	0.00963	95% H-Stat UCL	0.0234

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.00185	95% KM (Percentile Bootstrap) UCL	0.00184

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cobalt, Total

General Statistics

Total Number of Observations	12	Number of Distinct Observations	2
		Number of Missing Observations	88
Number of Detects	2	Number of Non-Detects	10
Number of Distinct Detects	1	Number of Distinct Non-Detects	2

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Cobalt, Total was not processed!

Manganese, Total

General Statistics

Total Number of Observations	49	Number of Distinct Observations	47
		Number of Missing Observations	65
Number of Detects	45	Number of Non-Detects	4
Number of Distinct Detects	45	Number of Distinct Non-Detects	3
Minimum Detect	5.4700E-4	Minimum Non-Detect	0.001
Maximum Detect	3.39	Maximum Non-Detect	0.5
Variance Detects	0.313	Percent Non-Detects	8.163%
Mean Detects	0.273	SD Detects	0.56
Median Detects	0.0412	CV Detects	2.047
Skewness Detects	4.255	Kurtosis Detects	22.14
Mean of Logged Detects	-3.115	SD of Logged Detects	2.346

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.524	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.945	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.313	**Lilliefors GOF Test**

5% Lilliefors Critical Value	0.132	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.255	Standard Error of Mean	0.0774
SD	0.535	95% KM (BCA) UCL	0.419
95% KM (t) UCL	0.385	95% KM (Percentile Bootstrap) UCL	0.394
95% KM (z) UCL	0.382	95% KM Bootstrap t UCL	0.503
90% KM Chebyshev UCL	0.487	95% KM Chebyshev UCL	0.592
97.5% KM Chebyshev UCL	0.738	99% KM Chebyshev UCL	1.025

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.642	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.846	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.129	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.142	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.367	k star (bias corrected MLE)	0.357
Theta hat (MLE)	0.745	Theta star (bias corrected MLE)	0.765
nu hat (MLE)	33.04	nu star (bias corrected)	32.17
MLE Mean (bias corrected)	0.273	MLE Sd (bias corrected)	0.457

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.227	nu hat (KM)	22.26
Approximate Chi Square Value (22.26, α)	12.54	Adjusted Chi Square Value (22.26, β)	12.31
95% Gamma Approximate KM-UCL (use when n>=50)	0.453	95% Gamma Adjusted KM-UCL (use when n<50)	0.461

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	5.4700E-4	Mean	0.254
Maximum	3.39	Median	0.0345
SD	0.54	CV	2.13
k hat (MLE)	0.367	k star (bias corrected MLE)	0.358
Theta hat (MLE)	0.691	Theta star (bias corrected MLE)	0.708
nu hat (MLE)	35.95	nu star (bias corrected)	35.08
MLE Mean (bias corrected)	0.254	MLE Sd (bias corrected)	0.424
		Adjusted Level of Significance (β)	0.0451
Approximate Chi Square Value (35.08, α)	22.53	Adjusted Chi Square Value (35.08, β)	22.23
95% Gamma Approximate UCL (use when n>=50)	0.395	95% Gamma Adjusted UCL (use when n<50)	0.4

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.95	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.945	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.104	**Lilliefors GOF Test**

5% Lilliefors Critical Value	0.132	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.252	Mean in Log Scale	-3.304
SD in Original Scale	0.541	SD in Log Scale	2.391
95% t UCL (assumes normality of ROS data)	0.382	95% Percentile Bootstrap UCL	0.387
95% BCA Bootstrap UCL	0.444	95% Bootstrap t UCL	0.504
95% H-UCL (Log ROS)	2.703		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-3.315	95% H-UCL (KM -Log)	2.871
KM SD (logged)	2.412	95% Critical H Value (KM-Log)	4.198
KM Standard Error of Mean (logged)	0.354		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.261	Mean in Log Scale	-3.213
SD in Original Scale	0.539	SD in Log Scale	2.425
95% t UCL (Assumes normality)	0.39	95% H-Stat UCL	3.326

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.592	95% GROS Adjusted Gamma UCL	0.4
95% Adjusted Gamma KM-UCL	0.461		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Molybdenum, Total

General Statistics

Total Number of Observations	12	Number of Distinct Observations	4
		Number of Missing Observations	88
Number of Detects	2	Number of Non-Detects	10
Number of Distinct Detects	2	Number of Distinct Non-Detects	2
Minimum Detect	0.03	Minimum Non-Detect	0.005
Maximum Detect	0.11	Maximum Non-Detect	0.01
Variance Detects	0.0032	Percent Non-Detects	83.33%
Mean Detects	0.07	SD Detects	0.0566
Median Detects	0.07	CV Detects	0.808
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	-2.857	SD of Logged Detects	0.919

Warning: Data set has only 2 Detected Values.

This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only

Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.0158	Standard Error of Mean	0.0119
SD	0.0292	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.0373	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.0355	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.0516	95% KM Chebyshev UCL	0.0678
97.5% KM Chebyshev UCL	0.0903	99% KM Chebyshev UCL	0.135

Gamma GOF Tests on Detected Observations Only

Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	2.685	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.0261	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	10.74	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.294	nu hat (KM)	7.05
		Adjusted Level of Significance (β)	0.029
Approximate Chi Square Value (7.05, α)	2.198	Adjusted Chi Square Value (7.05, β)	1.808
95% Gamma Approximate KM-UCL (use when n>=50)	0.0508	95% Gamma Adjusted KM-UCL (use when n<50)	0.0617

Lognormal GOF Test on Detected Observations Only

Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0124	Mean in Log Scale	-7.69
SD in Original Scale	0.0319	SD in Log Scale	3.027
95% t UCL (assumes normality of ROS data)	0.0289	95% Percentile Bootstrap UCL	0.0285
95% BCA Bootstrap UCL	0.0403	95% Bootstrap t UCL	0.299
95% H-UCL (Log ROS)	33.34		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0156	Mean in Log Scale	-4.949
SD in Original Scale	0.0306	SD in Log Scale	1.035
95% t UCL (Assumes normality)	0.0315	95% H-Stat UCL	0.0307

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.0373	95% KM (% Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Selenium, Total

General Statistics

Total Number of Observations	66	Number of Distinct Observations	48
		Number of Missing Observations	48
Number of Detects	50	Number of Non-Detects	16
Number of Distinct Detects	46	Number of Distinct Non-Detects	2
Minimum Detect	5.6300E-4	Minimum Non-Detect	5.0000E-4
Maximum Detect	0.219	Maximum Non-Detect	0.001
Variance Detects	0.00193	Percent Non-Detects	24.24%
Mean Detects	0.023	SD Detects	0.044
Median Detects	0.00359	CV Detects	1.913
Skewness Detects	2.947	Kurtosis Detects	9.278
Mean of Logged Detects	-5.078	SD of Logged Detects	1.583

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.562	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.947	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.333	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.125	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.0176	Standard Error of Mean	0.00486
SD	0.0391	95% KM (BCA) UCL	0.027
95% KM (t) UCL	0.0257	95% KM (Percentile Bootstrap) UCL	0.026
95% KM (z) UCL	0.0256	95% KM Bootstrap t UCL	0.0302
90% KM Chebyshev UCL	0.0321	95% KM Chebyshev UCL	0.0387
97.5% KM Chebyshev UCL	0.0479	99% KM Chebyshev UCL	0.0659

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	3.373	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.817	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.241	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.133	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.488	k star (bias corrected MLE)	0.472
Theta hat (MLE)	0.0471	Theta star (bias corrected MLE)	0.0487
nu hat (MLE)	48.84	nu star (bias corrected)	47.24
MLE Mean (bias corrected)	0.023	MLE Sd (bias corrected)	0.0334

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.202	nu hat (KM)	26.69
Approximate Chi Square Value (26.69, α)	15.91	Adjusted Chi Square Value (26.69, β)	15.73
95% Gamma Approximate KM-UCL (use when n>=50)	0.0295	95% Gamma Adjusted KM-UCL (use when n<50)	0.0298

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	5.6300E-4	Mean	0.0198
Maximum	0.219	Median	0.01
SD	0.0386	CV	1.945
k hat (MLE)	0.593	k star (bias corrected MLE)	0.576
Theta hat (MLE)	0.0334	Theta star (bias corrected MLE)	0.0344
nu hat (MLE)	78.31	nu star (bias corrected)	76.08
MLE Mean (bias corrected)	0.0198	MLE Sd (bias corrected)	0.0261
		Adjusted Level of Significance (β)	0.0464
Approximate Chi Square Value (76.08, α)	56.99	Adjusted Chi Square Value (76.08, β)	56.62
95% Gamma Approximate UCL (use when n>=50)	0.0265	95% Gamma Adjusted UCL (use when n<50)	0.0267

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.912	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.947	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.174	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.125	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0175	Mean in Log Scale	-5.876
SD in Original Scale	0.0394	SD in Log Scale	2.031
95% t UCL (assumes normality of ROS data)	0.0256	95% Percentile Bootstrap UCL	0.0264
95% BCA Bootstrap UCL	0.0279	95% Bootstrap t UCL	0.03
95% H-UCL (Log ROS)	0.0473		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0175	Mean in Log Scale	-5.721
SD in Original Scale	0.0394	SD in Log Scale	1.794
95% t UCL (Assumes normality)	0.0256	95% H-Stat UCL	0.0302

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

97.5% KM (Chebyshev) UCL	0.0479

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Thallium, Total

General Statistics

Total Number of Observations	12	Number of Distinct Observations	6
		Number of Missing Observations	88
Number of Detects	6	Number of Non-Detects	6
Number of Distinct Detects	5	Number of Distinct Non-Detects	2
Minimum Detect	1.0000E-4	Minimum Non-Detect	5.0000E-5
Maximum Detect	9.0000E-4	Maximum Non-Detect	1.0000E-4
Variance Detects	1.2667E-7	Percent Non-Detects	50%
Mean Detects	5.6667E-4	SD Detects	3.5590E-4
Median Detects	6.5000E-4	CV Detects	0.628
Skewness Detects	-0.429	Kurtosis Detects	-2.185
Mean of Logged Detects	-7.748	SD of Logged Detects	0.918

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.858	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.244	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.362	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	3.0833E-4	Standard Error of Mean	1.0932E-4
SD	3.4571E-4	95% KM (BCA) UCL	5.0417E-4
95% KM (t) UCL	5.0466E-4	95% KM (Percentile Bootstrap) UCL	5.0000E-4
95% KM (z) UCL	4.8815E-4	95% KM Bootstrap t UCL	4.9353E-4
90% KM Chebyshev UCL	6.3630E-4	95% KM Chebyshev UCL	7.8486E-4
97.5% KM Chebyshev UCL	9.9105E-4	99% KM Chebyshev UCL	0.0014

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.519	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.704	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.273	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.336	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.99	k star (bias corrected MLE)	1.106
Theta hat (MLE)	2.8479E-4	Theta star (bias corrected MLE)	5.1236E-4

nu hat (MLE)	23.88	nu star (bias corrected)	13.27
MLE Mean (bias corrected)	5.6667E-4	MLE Sd (bias corrected)	5.3883E-4

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.795	nu hat (KM)	19.09
Approximate Chi Square Value (19.09, α)	10.18	Adjusted Chi Square Value (19.09, β)	9.206
95% Gamma Approximate KM-UCL (use when n>=50)	5.7801E-4	95% Gamma Adjusted KM-UCL (use when n<50)	6.3942E-4

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	1.0000E-4	Mean	0.00528
Maximum	0.01	Median	0.00545
SD	0.00493	CV	0.934
k hat (MLE)	0.654	k star (bias corrected MLE)	0.546
Theta hat (MLE)	0.00808	Theta star (bias corrected MLE)	0.00968
nu hat (MLE)	15.69	nu star (bias corrected)	13.1
MLE Mean (bias corrected)	0.00528	MLE Sd (bias corrected)	0.00715
		Adjusted Level of Significance (β)	0.029
Approximate Chi Square Value (13.10, α)	5.962	Adjusted Chi Square Value (13.10, β)	5.245
95% Gamma Approximate UCL (use when n>=50)	0.0116	95% Gamma Adjusted UCL (use when n<50)	0.0132

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.836	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.249	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.362	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	3.0528E-4	Mean in Log Scale	-8.98
SD in Original Scale	3.6391E-4	SD in Log Scale	1.503
95% t UCL (assumes normality of ROS data)	4.9395E-4	95% Percentile Bootstrap UCL	4.8998E-4
95% BCA Bootstrap UCL	4.9893E-4	95% Bootstrap t UCL	5.6719E-4
95% H-UCL (Log ROS)	0.00228		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-8.826	95% H-UCL (KM -Log)	0.00108
KM SD (logged)	1.23	95% Critical H Value (KM-Log)	3.35
KM Standard Error of Mean (logged)	0.389		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	3.0625E-4	Mean in Log Scale	-8.883
SD in Original Scale	3.6277E-4	SD in Log Scale	1.351
95% t UCL (Assumes normality)	4.9432E-4	95% H-Stat UCL	0.00149

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	5.0466E-4	95% KM (Percentile Bootstrap) UCL	5.0000E-4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ATTACHMENT B – TIER I HENRY SITE
HUMAN HEALTH RISK CALCULATIONS

Table B-1
Tier I Henry Site Cancer Risk Calculation for a Current/Future Native American - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Dust Inhalation Dose (ug/m^3)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Dermal	URF $(ug/m^3)^{-1}$ [b] Inhalation	Pathway-Specific Cancer Risk Soil Ingestion	Pathway-Specific Cancer Risk Dermal	Pathway-Specific Cancer Risk Dust Inhalation	Chemical-Specific Risk
Arsenic	45.5	3.3E-05	2.4E-05	1.9E-07	1.5E+00	1.5E+00	4.3E-03	4.9E-05	3.6E-05	8.0E-10	**8.5E-05**
Cadmium	59.5	7.2E-05	9.8E-07	2.4E-07	na	na	1.8E-03	na	na	4.4E-10	4.4E-10
Cobalt	11.9	1.4E-05	2.0E-06	4.9E-08	na	na	9.0E-03	na	na	4.4E-10	4.4E-10
Nickel	425	5.1E-04	7.0E-05	1.7E-06	na	na	2.6E-04	na	na	4.5E-10	4.5E-10
										ILCR	**9E-05**

Notes:

[a] Maximum detected concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL	percent upper confidence limit	na	not available
ILCR	incremental lifetime cancer risk	URF	unit risk factor
mg/kg	milligrams per kilogram	ug/m^3	microgram per cubic meter
mg/kg-d	milligrams per kilogram per day		

Table B-2
Tier I Henry Site Noncancer Hazard Calculation for a Current/Future Native American - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Dust Inhalation Dose (mg/m^3)	Reference Dose (mg/kg-d) [b] Oral	Reference Dose (mg/kg-d) [b] Dermal	RfC (mg/m^3) [b] Inhalation	Pathway-Specific Hazard Soil Ingestion	Pathway-Specific Hazard Dermal	Pathway-Specific Hazard Dust Inhalation	Chemical-Specific HQ
Antimony	9.15	2.6E-05	3.5E-06	8.7E-11	4.0E-04	6.0E-05	na	6.4E-02	5.8E-02	na	0.12
Arsenic	45.5	7.7E-05	5.6E-05	4.3E-10	3.0E-04	3.0E-04	1.5E-05	2.6E-01	1.9E-01	2.9E-05	0.44
Cadmium	59.5	1.7E-04	2.3E-06	5.7E-10	1.0E-03	2.5E-05	1.0E-05	1.7E-01	9.1E-02	5.7E-05	0.26
Cobalt	11.9	3.4E-05	4.6E-06	1.1E-10	3.0E-04	3.0E-04	6.0E-06	1.1E-01	1.5E-02	1.9E-05	0.13
Manganese	2,040	5.7E-03	7.8E-04	1.9E-08	1.4E-01	5.6E-03	5.0E-05	4.1E-02	1.4E-01	3.9E-04	0.18
Nickel	425	1.2E-03	1.6E-04	4.1E-09	2.0E-02	8.0E-04	9.0E-05	6.0E-02	2.0E-01	4.5E-05	0.26
Selenium	318	9.0E-04	1.2E-04	3.0E-09	5.0E-03	1.5E-03	2.0E-02	1.8E-01	8.1E-02	1.5E-07	0.26
Thallium	2.31	6.5E-06	8.9E-07	2.2E-11	1.0E-05	1.0E-05	na	6.5E-01	8.9E-02	na	0.74
Uranium	74.4	2.1E-04	2.9E-05	7.1E-10	2.0E-04	2.0E-04	4.0E-05	1.0E+00	1.4E-01	1.8E-05	**1.2**
Vanadium	584	1.6E-03	2.2E-04	5.6E-09	5.0E-03	1.3E-04	1.0E-04	3.3E-01	1.7E+00	5.6E-05	**2.1**
										HI	**6**

Notes:
[a] Maximum detected concentration measured in upland soil samples collected from Henry Site sampling locations.
[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	mg/m^3	milligram per cubic meter
HQ	hazard quotient	na	not available

Table B-3
Tier I Henry Site Cancer Risk Calculation for a Hypothetical Future Resident - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Inhalation Dose (ug/m^3)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b]		URF $(ug/m^3)^{-1}$ [b]	Pathway-Specific Cancer Risk			Chemical-Specific Risk
					Oral	Dermal	Inhalation	Soil Ingestion	Dermal	Inhalation	
Arsenic	45.5	3.3E-05	2.4E-05	1.9E-07	1.5E+00	1.5E+00	4.3E-03	4.9E-05	3.6E-05	8.0E-10	**8.5E-05**
Cadmium	59.5	7.2E-05	9.8E-07	2.4E-07	na	na	1.8E-03	na	na	4.4E-10	4.4E-10
Cobalt	11.9	1.4E-05	2.0E-06	4.9E-08	na	na	9.0E-03	na	na	4.4E-10	4.4E-10
Nickel	425	5.1E-04	7.0E-05	1.7E-06	na	na	2.6E-04	na	na	4.5E-10	4.5E-10
										ILCR	**9E-05**

Notes:

[a] Maximum detected concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL	percent upper confidence limit
ILCR	incremental lifetime cancer risk
mg/kg	milligrams per kilogram
mg/kg-d	milligrams per kilogram per day
na	not available
URF	unit risk factor
ug/m^3	microgram per cubic meter

Table B-4
Tier I Henry Site Noncancer Hazard Calculation for a Hypothetical Future Resident - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Inhalation Dose (mg/m^3)	Reference Dose (mg/kg-d) [b]		RfC (mg/m^3) [b]	Pathway-Specific Hazard			Chemical-Specific HQ
					Oral	Dermal	Inhalation	Soil Ingestion	Dermal	Inhalation	
Antimony	9.15	2.6E-05	3.5E-06	8.7E-11	4.0E-04	6.0E-05	na	6.4E-02	5.8E-02	na	0.12
Arsenic	45.5	7.7E-05	5.6E-05	4.3E-10	3.0E-04	3.0E-04	1.5E-05	2.6E-01	1.9E-01	2.9E-05	0.44
Cadmium	59.5	1.7E-04	2.3E-06	5.7E-10	1.0E-03	2.5E-05	1.0E-05	1.7E-01	9.1E-02	5.7E-05	0.26
Cobalt	11.9	3.4E-05	4.6E-06	1.1E-10	3.0E-04	3.0E-04	6.0E-06	1.1E-01	1.5E-02	1.9E-05	0.13
Manganese	2,040	5.7E-03	7.8E-04	1.9E-08	1.4E-01	5.6E-03	5.0E-05	4.1E-02	1.4E-01	3.9E-04	0.18
Nickel	425	1.2E-03	1.6E-04	4.1E-09	2.0E-02	8.0E-04	9.0E-05	6.0E-02	2.0E-01	4.5E-05	0.26
Selenium	318	9.0E-04	1.2E-04	3.0E-09	5.0E-03	1.5E-03	2.0E-02	1.8E-01	8.1E-02	1.5E-07	0.26
Thallium	2.31	6.5E-06	8.9E-07	2.2E-11	1.0E-05	1.0E-05	na	6.5E-01	8.9E-02	na	0.74
Uranium	74.4	2.1E-04	2.9E-05	7.1E-10	2.0E-04	2.0E-04	4.0E-05	1.0E+00	1.4E-01	1.8E-05	**1.2**
Vanadium	584	1.6E-03	2.2E-04	5.6E-09	5.0E-03	1.3E-04	1.0E-04	3.3E-01	1.7E+00	5.6E-05	**2.1**
										HI	**6**

Notes:

[a] Maximum detected concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	mg/m^3	milligram per cubic meter
HQ	hazard quotient	na	not available
mg/kg	milligrams per kilogram	RfC	reference concentration

Table B-5
Tier I Henry Site Cancer Risk Calculation for a Current/Future Seasonal Rancher - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Dust Inhalation Dose (ug/m^3)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Dermal	URF $(ug/m^3)^{-1}$ [b] Inhalation	Pathway-Specific Cancer Risk Soil Ingestion	Pathway-Specific Cancer Risk Dermal	Pathway-Specific Cancer Risk Dust Inhalation	Chemical-Specific Risk
Arsenic	45.5	4.4E-06	5.3E-06	4.0E-07	1.5E+00	1.5E+00	4.3E-03	6.6E-06	8.0E-06	1.7E-09	**1.5E-05**
Cadmium	59.5	9.6E-06	2.2E-07	5.2E-07	na	na	1.8E-03	na	na	9.3E-10	9.3E-10
Cobalt	11.9	1.9E-06	4.3E-07	1.0E-07	na	na	9.0E-03	na	na	9.4E-10	9.4E-10
Nickel	425	6.8E-05	1.5E-05	3.7E-06	na	na	2.6E-04	na	na	9.7E-10	9.7E-10
										ILCR	**1E-05**

Notes:

[a] Maximum detected concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL	percent upper confidence limit	na	not available
ILCR	incremental lifetime cancer risk	URF	unit risk factor
mg/kg	milligrams per kilogram	ug/m^3	microgram per cubic meter
mg/kg-d	milligrams per kilogram per day		

Table B-6
Tier I Henry Site Noncancer Hazard Calculation for a Current/Future Seasonal Rancher - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Dust Inhalation Dose (mg/m^3)	Reference Dose (mg/kg-d) [b] Oral	Reference Dose (mg/kg-d) [b] Dermal	RfC (mg/m^3) [b] Inhalation	Pathway-Specific Hazard Soil Ingestion	Pathway-Specific Hazard Dermal	Pathway-Specific Hazard Dust Inhalation	Chemical-Specific HQ
Antimony	9.15	4.3E-06	9.7E-07	2.3E-10	4.0E-04	6.0E-05	na	1.1E-02	1.6E-02	na	0.027
Arsenic	45.5	1.3E-05	1.5E-05	1.2E-09	3.0E-04	3.0E-04	1.5E-05	4.3E-02	5.2E-02	7.7E-05	0.094
Cadmium	59.5	2.8E-05	6.3E-07	1.5E-09	1.0E-03	2.5E-05	1.0E-05	2.8E-02	2.5E-02	1.5E-04	0.053
Cobalt	11.9	5.6E-06	1.3E-06	3.0E-10	3.0E-04	3.0E-04	6.0E-06	1.9E-02	4.2E-03	5.1E-05	0.023
Manganese	2,040	9.6E-04	2.2E-04	5.2E-08	1.4E-01	5.6E-03	5.0E-05	6.8E-03	3.9E-02	1.0E-03	0.047
Nickel	425	2.0E-04	4.5E-05	1.1E-08	2.0E-02	8.0E-04	9.0E-05	1.0E-02	5.6E-02	1.2E-04	0.067
Selenium	318	1.5E-04	3.4E-05	8.1E-09	5.0E-03	1.5E-03	2.0E-02	3.0E-02	2.3E-02	4.1E-07	0.052
Thallium	2.31	1.1E-06	2.5E-07	5.9E-11	1.0E-05	1.0E-05	na	1.1E-01	2.5E-02	na	0.13
Uranium	74.4	3.5E-05	7.9E-06	1.9E-09	2.0E-04	2.0E-04	4.0E-05	1.7E-01	4.0E-02	4.7E-05	0.21
Vanadium	584	2.7E-04	6.2E-05	1.5E-08	5.0E-03	1.3E-04	1.0E-04	5.5E-02	4.8E-01	1.5E-04	0.53
										HI	1

Notes:

[a] Maximum detected concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	mg/m^3	milligram per cubic meter
HQ	hazard quotient	na	not available
mg/kg	milligrams per kilogram	RfC	reference concentration

Table B-7
Summary of Tier I Henry Site Human Health Risk Estimates - Upland Soil

Analyte	Concentration[a] (mg/kg)			Current/Future Native American		Hypothetical Future Resident		Current/Future Seasonal Rancher	
	Maximum	95% UCL	EPC[b]	ILCR	HQ	ILCR	HQ	ILCR	HQ
Antimony	9.15	NA	9.15	NA	0.12	NA	0.12	NA	0.027
Arsenic	45.5	NA	45.5	**8.5E-05**	0.44	**8.5E-05**	0.44	**1.5E-05**	0.094
Cadmium	59.5	NA	59.5	4.4E-10	0.26	4.4E-10	0.26	9.3E-10	0.053
Cobalt	11.9	NA	11.9	4.4E-10	0.13	4.4E-10	0.13	9.4E-10	0.023
Manganese	2,040	NA	2,040	NA	0.18	NA	0.18	NA	0.047
Nickel	425	NA	425	4.5E-10	0.26	4.5E-10	0.26	9.7E-10	0.067
Selenium	318	NA	318	NA	0.26	NA	0.26	NA	0.052
Thallium	2.31	NA	2.31	NA	0.74	NA	0.74	NA	0.13
Uranium	74.4	NA	74.4	NA	**1.2**	NA	**1.2**	NA	0.21
Vanadium	584	NA	584	NA	**2.1**	NA	**2.1**	NA	0.53
			Cumulative ILCR/HQ:	**9E-05**	**6**	**9E-05**	**6**	**1E-05**	1
			IDEQ Point of Departure:	10^{-5}	1				
			USEPA Risk Range:	10^{-6} - 10^{-4}	1				

Notes:

[a] Maximum detected concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] The exposure point concentration (EPC) is the maximum detected concentration.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
NA - not applicable
USEPA - U. S. Environmental Protection Agency

Table B-8
Tier I Henry Site Cancer Risk Calculation for a Current/Future Native American - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Dust Inhalation Dose (ug/m^3)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Dermal	URF $(ug/m^3)^{-1}$ [b] Inhalation	Pathway-Specific Cancer Risk Soil Ingestion	Pathway-Specific Cancer Risk Dermal	Pathway-Specific Cancer Risk Dust Inhalation	Chemical-Specific Risk
Arsenic	4.99	3.6E-06	2.6E-06	2.0E-08	1.5E+00	1.5E+00	4.3E-03	5.4E-06	3.9E-06	8.8E-11	**9.4E-06**
Cadmium	67.3	8.1E-05	1.1E-06	2.8E-07	na	na	1.8E-03	na	na	5.0E-10	5.0E-10
Cobalt	8.73	1.1E-05	1.4E-06	3.6E-08	na	na	9.0E-03	na	na	3.2E-10	3.2E-10
Nickel	251	3.0E-04	4.1E-05	1.0E-06	na	na	2.6E-04	na	na	2.7E-10	2.7E-10
										ILCR	**9E-06**

Notes:

[a] Maximum detected concentration measured in riparian soil samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL	percent upper confidence limit	na	not available
ILCR	incremental lifetime cancer risk	URF	unit risk factor
mg/kg	milligrams per kilogram	ug/m^3	microgram per cubic meter
mg/kg-d	milligrams per kilogram per day		

Table B-9
Tier I Henry Site Noncancer Hazard Calculation for a Current/Future Native American - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Dust Inhalation Dose (mg/m^3)	Reference Dose (mg/kg-d) [b] Oral	Reference Dose (mg/kg-d) [b] Dermal	RfC (mg/m^3) [b] Inhalation	Pathway-Specific Hazard Soil Ingestion	Pathway-Specific Hazard Dermal	Pathway-Specific Hazard Dust Inhalation	Chemical-Specific HQ
Antimony	7.00	2.0E-05	2.7E-06	6.7E-11	4.0E-04	6.0E-05	na	4.9E-02	4.5E-02	na	0.094
Arsenic	4.99	8.4E-06	6.1E-06	4.8E-11	3.0E-04	3.0E-04	1.5E-05	2.8E-02	2.0E-02	3.2E-06	0.049
Cadmium	67.3	1.9E-04	2.6E-06	6.4E-10	1.0E-03	2.5E-05	1.0E-05	1.9E-01	1.0E-01	6.4E-05	0.29
Cobalt	8.73	2.5E-05	3.3E-06	8.3E-11	3.0E-04	3.0E-04	6.0E-06	8.2E-02	1.1E-02	1.4E-05	0.093
Manganese	1,080	3.0E-03	4.1E-04	1.0E-08	1.4E-01	5.6E-03	5.0E-05	2.2E-02	7.4E-02	2.1E-04	0.096
Nickel	251	7.1E-04	9.6E-05	2.4E-09	2.0E-02	8.0E-04	9.0E-05	3.5E-02	1.2E-01	2.7E-05	0.16
Selenium	45.0	1.3E-04	1.7E-05	4.3E-10	5.0E-03	1.5E-03	2.0E-02	2.5E-02	1.2E-02	2.1E-08	0.037
Thallium	0.223	6.3E-07	8.6E-08	2.1E-12	1.0E-05	1.0E-05	na	6.3E-02	8.6E-03	na	0.071
Vanadium	773	2.2E-03	3.0E-04	7.4E-09	5.0E-03	1.3E-04	1.0E-04	4.4E-01	2.3E+00	7.4E-05	**2.7**
										HI	**4**

Notes:

[a] Maximum detected concentration measured in riparian soil samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	mg/m^3	milligram per cubic meter
HQ	hazard quotient	na	not available
mg/kg	milligrams per kilogram	RfC	reference concentration

Table B-10
Tier I Henry Site Cancer Risk Calculation for a Current/Future Recreational Fisher, and Current/Future Native American and Hypothetical Future Resident who Fish - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Dust Inhalation Dose (ug/m^3)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Dermal	URF $(ug/m^3)^{-1}$ [b] Inhalation	Pathway-Specific Cancer Risk Soil Ingestion	Pathway-Specific Cancer Risk Dermal	Pathway-Specific Cancer Risk Dust Inhalation	Chemical-Specific Risk
Arsenic	4.99	2.9E-07	2.1E-07	3.3E-09	1.5E+00	1.5E+00	4.3E-03	4.4E-07	3.2E-07	1.4E-11	7.6E-07
Cadmium	67.3	6.6E-06	9.0E-08	4.5E-08	na	na	1.8E-03	na	na	8.1E-11	8.1E-11
Cobalt	8.73	8.6E-07	1.2E-07	5.8E-09	na	na	9.0E-03	na	na	5.2E-11	5.2E-11
Nickel	251	2.5E-05	3.4E-06	1.7E-07	na	na	2.6E-04	na	na	4.4E-11	4.4E-11
										ILCR	8E-07

Notes:

[a] Maximum detected concentration measured in riparian soil samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL	percent upper confidence limit	na	not available
ILCR	incremental lifetime cancer risk	URF	unit risk factor
mg/kg	milligrams per kilogram	ug/m^3	microgram per cubic meter
mg/kg-d	milligrams per kilogram per day		

Table B-11
Tier I Henry Site Noncancer Hazard Calculation for a Current/Future Recreational Fisher, and Current/Future Native American and Hypothetical Future Resident who Fish - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Dust Inhalation Dose (mg/m^3)	Reference Dose (mg/kg-d) [b] Oral	Reference Dose (mg/kg-d) [b] Dermal	RfC (mg/m^3) [b] Inhalation	Pathway-Specific Hazard Soil Ingestion	Pathway-Specific Hazard Dermal	Pathway-Specific Hazard Dust Inhalation	Chemical-Specific HQ
Antimony	7.00	1.6E-06	2.2E-07	6.7E-11	4.0E-04	6.0E-05	na	4.0E-03	3.6E-03	na	0.0077
Arsenic	4.99	6.9E-07	5.0E-07	4.8E-11	3.0E-04	3.0E-04	1.5E-05	2.3E-03	1.7E-03	3.2E-06	0.0040
Cadmium	67.3	1.5E-05	2.1E-07	6.4E-10	1.0E-03	2.5E-05	1.0E-05	1.5E-02	8.4E-03	6.4E-05	0.024
Cobalt	8.73	2.0E-06	2.7E-07	8.3E-11	3.0E-04	3.0E-04	6.0E-06	6.7E-03	9.1E-04	1.4E-05	0.0076
Manganese	1,080	2.5E-04	3.4E-05	1.0E-08	1.4E-01	5.6E-03	5.0E-05	1.8E-03	6.0E-03	2.1E-04	0.0080
Nickel	251	5.8E-05	7.8E-06	2.4E-09	2.0E-02	8.0E-04	9.0E-05	2.9E-03	9.8E-03	2.7E-05	0.013
Selenium	45.0	1.0E-05	1.4E-06	4.3E-10	5.0E-03	1.5E-03	2.0E-02	2.1E-03	9.4E-04	2.1E-08	0.0030
Thallium	0.223	5.1E-08	7.0E-09	2.1E-12	1.0E-05	1.0E-05	na	5.1E-03	7.0E-04	na	0.0058
Vanadium	773	1.8E-04	2.4E-05	7.4E-09	5.0E-03	1.3E-04	1.0E-04	3.5E-02	1.9E-01	7.4E-05	0.22
										HI	0.3

Notes:
[a] Maximum detected concentration measured in riparian soil samples collected from Henry Site sampling locations.
[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	mg/m^3	milligram per cubic meter
HQ	hazard quotient	na	not available
mg/kg	milligrams per kilogram	RfC	reference concentration

Table B-12
Summary of Tier I Henry Site Human Health Risk Estimates - Riparian Soil

Analyte	Concentration[a] (mg/kg)			Current/Future Native American		Recreational Fisher / Native American or Resident who Fishes	
	Maximum	95% UCL	EPC[b]	ILCR	HQ	ILCR	HQ
Antimony	7.00	NA	7.00	NA	0.094	NA	0.0077
Arsenic	4.99	NA	4.99	**9.4E-06**	0.049	7.6E-07	0.0040
Cadmium	67.3	NA	67.3	5.0E-10	0.29	8.1E-11	0.024
Cobalt	8.7	NA	8.73	3.2E-10	0.093	5.2E-11	0.0076
Manganese	1,080	NA	1,080	NA	0.096	NA	0.0080
Nickel	251	NA	251	2.7E-10	0.16	4.4E-11	0.013
Selenium	45.0	NA	45.0	NA	0.037	NA	0.0030
Thallium	0.223	NA	0.223	NA	0.071	NA	0.0058
Vanadium	773	NA	773	NA	**2.7**	NA	0.22
Cumulative ILCR/HQ:				**9E-06**	**4**	8E-07	0.3
IDEQ Point of Departure:				10^{-5}	1		
USEPA Risk Range:				10^{-6} - 10^{-4}	1		

Notes:

[a] Maximum detected concentration measured in riparian soil samples collected from Henry Site sampling locations.

[b] The exposure point concentration (EPC) is the maximum detected concentration.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
NA - not applicable
USEPA - U. S. Environmental Protection Agency

Table B-13
Tier I Henry Site Cancer Risk Calculation for a Current/Future Native American - Surface Water

Analyte	Surface Water Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Dermal	Pathway-Specific Cancer Risk Ingestion	Pathway-Specific Cancer Risk Dermal	Chemical-Specific Risk
Arsenic	0.0224	2.0E-06	7.5E-07	1.5E+00	1.5E+00	3.0E-06	1.1E-06	**4.2E-06**
							ILCR	**4E-06**

Notes:

[a] Maximum detected concentration measured in surface water samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor

% UCL percent upper confidence limit
ILCR incremental lifetime cancer risk
mg/L milligrams per liter
mg/kg-d milligrams per kilogram per day

Table B-14
Tier I Henry Site Noncancer Hazard Calculation for a Current/Future Native American - Surface Water

Analyte	Surface Water Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Reference Dose (mg/kg-d)[b] Oral	Reference Dose (mg/kg-d)[b] Dermal	Pathway-Specific Hazard Ingestion	Pathway-Specific Hazard Dermal	Chemical-Specific HQ
Arsenic	0.0224	4.7E-06	1.7E-06	3.0E-04	3.0E-04	1.6E-02	5.8E-03	0.022
Cadmium	0.0352	7.4E-06	2.7E-06	5.0E-04	2.5E-05	1.5E-02	1.1E-01	0.12
Chromium	0.00760	1.6E-06	5.9E-07	1.5E+00	2.0E-02	1.1E-06	3.0E-05	0.000031
Cobalt	0.0141	3.0E-06	4.4E-07	3.0E-04	3.0E-04	9.9E-03	1.5E-03	0.011
Manganese	20.4	4.3E-03	1.6E-03	1.4E-01	5.6E-03	3.1E-02	2.8E-01	0.32
Nickel	1.26	2.7E-04	2.0E-05	2.0E-02	8.0E-04	1.3E-02	2.5E-02	0.038
Selenium	0.970	2.0E-04	7.6E-05	5.0E-03	1.5E-03	4.1E-02	5.0E-02	0.091
Thallium	0.000348	7.3E-08	2.7E-08	1.0E-05	1.0E-05	7.3E-03	2.7E-03	0.010
Vanadium	0.0885	1.9E-05	6.9E-06	5.0E-03	1.3E-04	3.7E-03	5.3E-02	0.057
							HI	0.7

Notes:

[a] Maximum detected concentration measured in surface water samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index		
HQ	hazard quotient		

Table B-15

Tier I Henry Site Cancer Risk Calculation for a Current/Future Recreational Fisher and Hypothetical Future Resident - Surface Water

Analyte	Surface Water Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Dermal	Pathway-Specific Cancer Risk Ingestion	Pathway-Specific Cancer Risk Dermal	Chemical-Specific Risk
Arsenic	0.0224	3.1E-07	1.1E-07	1.5E+00	1.5E+00	4.6E-07	1.7E-07	6.4E-07
							ILCR	6E-07

Notes:

[a] Maximum detected concentration measured in surface water samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor

% UCL	percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk		
mg/L	milligrams per liter		

Table B-16
Tier I Henry Site Noncancer Hazard Calculation for a Current/Future Recreational Fisher and Hypothetical Future Resident - Surface Water

Analyte	Surface Water Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Reference Dose (mg/kg-d) [b] Dermal	Pathway-Specific Hazard Ingestion	Pathway-Specific Hazard Dermal	Chemical-Specific HQ
Arsenic	0.0224	7.2E-07	2.7E-07	3.0E-04	3.0E-04	2.4E-03	8.9E-04	0.0033
Cadmium	0.0352	1.1E-06	4.2E-07	5.0E-04	2.5E-05	2.3E-03	1.7E-02	0.019
Chromium	0.00760	2.5E-07	9.1E-08	1.5E+00	2.0E-02	1.6E-07	4.6E-06	0.0000048
Cobalt	0.0141	4.5E-07	6.7E-08	3.0E-04	3.0E-04	1.5E-03	2.2E-04	0.0017
Manganese	20.4	6.6E-04	2.4E-04	1.4E-01	5.6E-03	4.7E-03	4.3E-02	0.048
Nickel	1.26	4.1E-05	3.0E-06	2.0E-02	8.0E-04	2.0E-03	3.8E-03	0.0058
Selenium	0.970	3.1E-05	1.2E-05	5.0E-03	1.5E-03	6.3E-03	7.7E-03	0.014
Thallium	0.000348	1.1E-08	4.2E-09	1.0E-05	1.0E-05	1.1E-03	4.2E-04	0.0015
Vanadium	0.0885	2.9E-06	1.1E-06	5.0E-03	1.3E-04	5.7E-04	8.1E-03	0.0087
							HI	0.1

Notes:

[a] Maximum detected concentration measured in surface water samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index		
HQ	hazard quotient		

Table B-17
Summary of Tier I Henry Site Human Health Risk Estimates - Surface Water

Analyte	Concentration[a] (mg/L)			Current/Future Native American		Current/Future Recreational Fisher / Hypothetical Future Resident who Fishes	
	Maximum	95% UCL	EPC[b]	ILCR	HQ	ILCR	HQ
Arsenic	0.0224	NA	0.0224	**4E-06**	0.022	6E-07	0.0033
Cadmium	0.0352	NA	0.0352	NA	0.12	NA	0.019
Chromium	0.00760	NA	0.00760	NA	0.000031	NA	0.0000048
Cobalt	0.0141	NA	0.0141	NA	0.011	NA	0.0017
Manganese	20.4	NA	20.4	NA	0.32	NA	0.048
Nickel	1.26	NA	1.26	NA	0.038	NA	0.0058
Selenium	0.970	NA	0.97	NA	0.091	NA	0.014
Thallium	0.000348	NA	0.000348	NA	0.010	NA	0.0015
Vanadium	0.0885	NA	0.0885	NA	0.057	NA	0.0087
Cumulative ILCR/HQ				**4E-06**	0.7	6E-07	0.1
IDEQ Point of Departure:				10^{-5}	1		
USEPA Risk Range:				10^{-6} - 10^{-4}	1		

Notes:

[a] Maximum detected concentration measured in surface water samples collected from Henry Site sampling locations.

[b] The exposure point concentration (EPC) is the maximum detected concentration.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/L - milligrams per liter
NA - not applicable
USEPA - U. S. Environmental Protection Agency

Table B-18
Tier I Henry Site Cancer Risk Calculation for a Hypothetical Future Resident - Groundwater

Analyte	Groundwater Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Dermal	Pathway-Specific Cancer Risk Ingestion	Pathway-Specific Cancer Risk Dermal	Chemical-Specific Risk
Arsenic	0.00430	7.6E-05	4.4E-07	1.5E+00	1.5E+00	1.1E-04	6.6E-07	**1.1E-04**
							ILCR	**1E-04**

Notes:

[a] Maximum detected concentration measured in groundwater samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor

% UCL	percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	NA	not applicable
mg/L	milligrams per liter		

Table B-19
Tier I Henry Site Noncancer Hazard Calculation for a Hypothetical Future Resident - Groundwater

Analyte	Groundwater Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b]		Pathway-Specific Hazard		Chemical-Specific HQ
				Oral	Dermal	Ingestion	Dermal	
Arsenic	0.00430	1.8E-04	1.0E-06	3.0E-04	3.0E-04	5.9E-01	3.4E-03	0.59
Chromium	0.00380	1.6E-04	9.0E-07	1.5E+00	2.0E-02	1.0E-04	4.6E-05	0.00015
Cobalt	0.0100	4.1E-04	9.5E-07	3.0E-04	3.0E-04	1.4E+00	3.2E-03	**1.4**
Manganese	3.39	1.4E-01	8.0E-04	1.4E-01	5.6E-03	1.0E+00	1.4E-01	**1.1**
Molybdenum	0.110	4.5E-03	2.6E-05	5.0E-03	5.0E-03	9.0E-01	5.2E-03	0.91
Selenium	0.219	9.0E-03	5.2E-05	5.0E-03	1.5E-03	1.8E+00	3.5E-02	**1.8**
Thallium	0.000900	3.7E-05	2.1E-07	1.0E-05	1.0E-05	3.7E+00	2.1E-02	**3.7**
							HI	**10**

Notes:

[a] Maximum detected concentration measured in groundwater samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose

% UCL	percent upper confidence limit	mg/kg	milligrams per kilogram
HI	hazard index	mg/kd-d	milligrams per kilogram per day
HQ	hazard quotient	NA	not applicable

Table B-20
Tier I Henry Site Cancer Risk Calculation for a Current/Future Seasonal Rancher - Groundwater

Analyte	Groundwater Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Dermal	Pathway-Specific Cancer Risk Ingestion	Pathway-Specific Cancer Risk Dermal	Chemical-Specific Risk
Arsenic	0.00430	1.4E-05	9.5E-08	1.5E+00	1.5E+00	2.1E-05	1.4E-07	**2.1E-05**
							ILCR	**2E-05**

Notes:

[a] Maximum detected concentration measured in groundwater samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor

% UCL	percent upper confidence limit
ILCR	incremental lifetime cancer risk
mg/L	milligrams per liter
mg/kg-d	milligrams per kilogram per day
NA	not applicable

Table B-21
Tier I Henry Site Noncancer Hazard Calculation for a Current/Future Seasonal Rancher - Groundwater

Analyte	Groundwater Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b]		Pathway-Specific Hazard		Chemical-Specific HQ
				Oral	Dermal	Ingestion	Dermal	
Arsenic	0.00430	1.7E-06	2.8E-07	3.0E-04	3.0E-04	5.6E-03	9.2E-04	0.0065
Chromium	0.00380	1.5E-06	2.4E-07	1.5E+00	2.0E-02	9.9E-07	1.3E-05	0.000014
Cobalt	0.0100	3.9E-06	2.6E-07	3.0E-04	3.0E-04	1.3E-02	8.6E-04	0.014
Manganese	3.39	1.3E-03	2.2E-04	1.4E-01	5.6E-03	9.5E-03	3.9E-02	0.048
Molybdenum	0.110	4.3E-05	7.1E-06	5.0E-03	5.0E-03	8.6E-03	1.4E-03	0.010
Selenium	0.219	8.6E-05	1.4E-05	5.0E-03	1.5E-03	1.7E-02	9.4E-03	0.027
Thallium	0.000900	3.5E-07	5.8E-08	1.0E-05	1.0E-05	3.5E-02	5.8E-03	0.041
							HI	0.1

Notes:

[a] Maximum detected concentration measured in groundwater samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose

% UCL	percent upper confidence limit	mg/kg	milligrams per kilogram
HI	hazard index	mg/kd-d	milligrams per kilogram per day
HQ	hazard quotient	NA	not applicable

Table B-22
Summary of Tier I Henry Site Human Health Risk Estimates - Groundwater

Analyte	Concentration[a] (mg/L)			Hypothetical Future Resident		Current/Future Seasonal Rancher	
	Maximum	95% UCL	EPC[b]	ILCR	HQ	ILCR	HQ
Arsenic	0.00430	NA	0.00430	**1.1E-04**	0.59	**2.1E-05**	0.0065
Chromium	0.00380	NA	0.00380	NA	0.00015	NA	0.000014
Cobalt	0.0100	NA	0.0100	NA	**1.4**	NA	0.014
Manganese	3.39	NA	3.39	NA	**1.1**	NA	0.048
Molybdenum	0.110	NA	0.110	NA	0.91	NA	0.010
Selenium	0.219	NA	0.219	NA	**1.8**	NA	0.027
Thallium	0.000900	NA	0.000900	NA	**3.7**	NA	0.041
Cumulative ILCR/HQ				**1E-04**	**10**	**2E-05**	0.1
IDEQ Point of Departure:				10^{-5}	1		
USEPA Risk Range:				10^{-6} - 10^{-4}	1		

Notes:

[a] Maximum detected concentration measured in groundwater samples collected from Henry Site sampling locations.

[b] The exposure point concentration (EPC) is the maximum detected concentration.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/L - milligrams per liter
NA - not applicable
USEPA - U. S. Environmental Protection Agency

Table B-23
Tier I Henry Site Cancer Risk Calculation for a Current/Future Native American - Culturally Significant Plants - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Modeled Culturally Significant Plant Concentration from Soil (mg/kg)	Measured Culturally Significant Plants Concentration (mg/kg)	Modeled Plant Ingestion Dose (mg/kg-d)	Measured Plant Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Pathway-Specific Cancer Risk: Modeled Plant Ingestion	Pathway-Specific Cancer Risk: Measured Plant Ingestion	Chemical-Specific Risk [c]
Arsenic	45.5	1.07	0.0459	2.4E-03	1.0E-04	1.5E+00	3.6E-03	1.5E-04	**1.5E-04**
								ILCR	**2E-04**

Notes:

[a] The exposure point concentration (EPC) is equal to the maximum detected concentration.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

[c] Where available, measured plant concentrations were used preferentially over modeled plant concentrations to calculate risk.

% UCL	percent upper confidence limit	mg/kg	milligrams per kilogram
ILCR	incremental lifetime cancer risk	mg/kg-d	milligrams per kilogram per day

Table B-24
Tier I Henry Site Noncancer Hazard Calculation for a Current/Future Native American - Culturally Significant Plants - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Modeled Culturally Significant Plant Concentration from Soil (mg/kg)	Measured Culturally Significant Plants Concentration (mg/kg)	Modeled Plant Ingestion Dose (mg/kg-d)	Measured Plant Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Pathway-Specific Hazard Modeled Plant Ingestion	Pathway-Specific Hazard Measured Plant Ingestion	Chemical-Specific HQ [c]
Antimony	9.15	0.581	0.170	3.0E-03	8.8E-04	4.0E-04	7.6	2.2	**2.2**
Arsenic	45.5	1.07	0.0459	5.6E-03	2.4E-04	3.0E-04	19	0.80	0.80
Cadmium	59.5	8.24	1.89	4.3E-02	9.8E-03	1.0E-03	43	9.8	**9.8**
Cobalt	11.9	0.220	0.171	1.1E-03	8.9E-04	3.0E-04	3.8	3.0	**3.0**
Manganese	2,040	155	23.8	8.1E-01	1.2E-01	1.4E-01	5.8	0.89	0.89
Nickel	425	12.1	1.56	6.3E-02	8.1E-03	2.0E-02	3.2	0.41	0.41
Selenium	318	6.29	1.79	3.3E-02	9.3E-03	5.0E-03	6.5	1.9	**1.9**
Thallium	2.31	0.0335	0.00335	1.7E-04	1.7E-05	1.0E-05	17	1.7	**1.7**
Uranium	74.4	1.16	0.0335	6.1E-03	1.7E-04	2.0E-04	30	0.87	0.87
Vanadium	584	8.70	0.371	4.5E-02	1.9E-03	5.0E-03	9.1	0.39	0.39
								HI	**22**

Notes:

[a] The exposure point concentration (EPC) is equal to the maximum detected concentration.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

[c] Where available, measured plant concentrations were used preferentially over modeled plant concentrations to calculate an HQ.

% UCL	percent upper confidence limit	mg/kg	milligrams per kilogram
HI	hazard index	mg/kd-d	milligrams per kilogram per day
HQ	hazard quotient		

Table B-25
Summary of Tier I Henry Site Human Health Risk Estimates - Culturally Significant Plants - Upland Soil

	Upland Soil Concentration[a] (mg/kg)			Modeled Culturally Significant Plants Concentration (mg/kg)	Measured Culturally Significant Plants Concentration (mg/kg)	Current/Future Native American	
Analyte	**Maximum**	**95% UCL**	**EPC[b]**	**EPC[c]**	**EPC[d]**	**ILCR**	**HQ**
Antimony	9.15	NA	9.15	0.581	0.170	NA	**2.2**
Arsenic	45.5	NA	45.5	1.07	0.0459	**1.5E-04**	0.80
Cadmium	59.5	NA	59.5	8.24	1.89	NA	**9.8**
Cobalt	11.9	NA	11.9	0.220	0.171	NA	**3.0**
Manganese	2,040	NA	2,040	155	23.8	NA	0.89
Nickel	425	NA	425	12.1	1.56	NA	0.41
Selenium	318	NA	318	6.29	1.79	NA	**1.9**
Thallium	2.31	NA	2.31	0.0335	0.00335	NA	**1.7**
Uranium	74.4	NA	74.4	1.16	0.0335	NA	0.87
Vanadium	584	NA	584	8.70	0.371	NA	0.39
					Cumulative ILCR/HQ:	**2E-04**	**22**
					IDEQ Point of Departure:	10^{-5}	1
					USEPA Risk Range:	10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] The exposure point concentration (EPC) is equal to the maximum detected concentration.

[c] The culturally significant plants EPC was modeled from the upland soil EPC using soil-to-plant uptake factors.

[d] The maximum detected concentration measured in culturally significant plants samples in wet weight. The dry weight culturally significant plants data were converted to wet weight using an average moisture content of 66 percent. For antimony, thallium, and uranium, the measured plant concentration is based on the maximum detection limit, as these analytes were not detected in upland culturally significant plant tissue samples.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
NA - not applicable
USEPA - U. S. Environmental Protection Agency

Table B-26
Tier I Henry Site Cancer Risk Calculation for a Current/Future Native American - Culturally Significant Plants - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg)	Modeled Culturally Significant Plant Concentration from Soil (mg/kg)	Measured Riparian Plant Concentration (mg/kg)	Modeled Plant Ingestion Dose (mg/kg-d)	Measured Plant Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Pathway-Specific Cancer Risk: Modeled Plant Ingestion	Pathway-Specific Cancer Risk: Measured Plant Ingestion	Chemical-Specific Risk [c]
Arsenic	4.99	0.117	na	2.6E-04	na	1.5E+00	3.9E-04	na	**3.9E-04**
								ILCR	**4E-04**

Notes:

[a] The exposure point concentration (EPC) is equal to the maximum detected concentration.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

[c] Where available, measured plant concentrations were used preferentially over modeled plant concentrations to calculate risk.

% UCL	percent upper confidence limit
ILCR	incremental lifetime cancer risk
mg/kg	milligrams per kilogram
mg/kg-d	milligrams per kilogram per day
na	not available

Table B-27
Tier I Henry Site Noncancer Hazard Calculation for a Current/Future Native American - Culturally Significant Plants - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg)	Modeled Culturally Significant Plant Concentration from Soil (mg/kg)	Measured Riparian Plant Concentration (mg/kg)	Modeled Plant Ingestion Dose (mg/kg-d)	Measured Plant Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Pathway-Specific Hazard: Modeled Plant Ingestion	Pathway-Specific Hazard: Measured Plant Ingestion	Chemical-Specific HQ [c]
Antimony	7.00	0.445	na	2.3E-03	na	4.0E-04	5.8E+00	na	**5.8**
Arsenic	4.99	0.117	na	6.1E-04	na	3.0E-04	2.0E+00	na	**2.0**
Cadmium	67.3	9.32	0.976	4.9E-02	5.1E-03	1.0E-03	4.9E+01	5.1E+00	**5.1**
Cobalt	8.73	0.162	na	8.4E-04	na	3.0E-04	2.8E+00	na	**2.8**
Manganese	1,080	82.1	na	4.3E-01	na	1.4E-01	3.1E+00	na	**3.1**
Nickel	251	7.16	na	3.7E-02	na	2.0E-02	1.9E+00	na	**1.9**
Selenium	45.0	0.890	22.1	4.6E-03	1.2E-01	5.0E-03	9.3E-01	2.3E+01	**23**
Thallium	0.223	0.00324	na	1.7E-05	na	1.0E-05	1.7E+00	na	**1.7**
Vanadium	773	11.5	na	6.0E-02	na	5.0E-03	1.2E+01	na	**12**
								HI	**57**

Notes:

[a] The exposure point concentration (EPC) is equal to the maximum detected concentration.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

[c] Where available, measured plant concentrations were used preferentially over modeled plant concentrations to calculate an HQ.

HI	hazard index	mg/kd-d	milligrams per kilogram per day
HQ	hazard quotient	na	not available
mg/kg	milligrams per kilogram		

Table B-28
Summary of Tier I Henry Site Human Health Risk Estimates - Culturally Significant Plants - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg)			Modeled Culturally Significant Plants Concentration (mg/kg)	Measured Riparian Plants Concentration (mg/kg)	Current/Future Native American	
	Maximum	**95% UCL**	**EPC[b]**	**EPC[c]**	**EPC[d]**	**ILCR**	**HQ**
Antimony	7.00	NA	7.00	0.445	na	NA	**5.8**
Arsenic	4.99	NA	4.99	0.117	na	**3.9E-04**	**2.0**
Cadmium	67.3	NA	67.3	9.32	0.976	NA	**5.1**
Cobalt	8.73	NA	8.73	0.162	na	NA	**2.8**
Manganese	1,080	NA	1,080	82.1	na	NA	**3.1**
Nickel	251	NA	251	7.16	na	NA	**1.9**
Selenium	45.0	NA	45.0	0.890	22.1	NA	**23**
Thallium	0.223	NA	0.223	0.00324	na	NA	**1.7**
Vanadium	773	NA	773	11.5	na	NA	**12**
					Cumulative ILCR/HQ:	**4E-04**	**57**
					IDEQ Point of Departure:	10^{-5}	1
					USEPA Risk Range:	10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration measured in riparian soil samples collected from Henry Site sampling locations.

[b] The exposure point concentration (EPC) is equal to the maximum detected concentration.

[c] The culturally significant plants EPC was modeled from the riparian soil EPC using soil-to-plant uptake factors.

[d] The maximum detected concentration measured in culturally significant plants samples in wet weight. The dry weight culturally significant plants data were converted to wet weight using an average moisture content of 66 percent.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk

mg/kg - milligrams per kilogarm
NA - not applicable
na - not available
USEPA - U. S. Environmental Protection Agency

Table B-29
Tier I Henry Site Cancer Risk Calculation for a Hypothetical Future Resident - Fruits and Vegetables - Upland Soil and Groundwater

Analyte	Upland Soil Concentration[a] (mg/kg)	Groundwater Concentration[a] (mg/L)	Modeled Fruits and Vegetables Concentration from Soil (mg/kg)	Modeled Fruits and Vegetables Concentration from Groundwater (mg/kg)	Measured Non-Culturally Significant Plants Concentration (mg/kg)	Total Fruits and Vegetables Concentration [b] (mg/kg)	Plant Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [c] Oral	Chemical-Specific Risk
Arsenic	45.5	0.00430	1.07	0.0193	3.47	3.49	7.8E-03	1.5E+00	**1.2E-02**
								ILCR	**1E-02**

Notes:

[a] Maximum detected concentration measured in fruits and vegetables samples collected from Henry Site sampling locations.

[b] For an analyte that is only a chemical of potential concern (COPC) in soil, measured non-culturally significant plant concentration, when available, was used to represent the fruits and vegetables concentration. If an analyte is a COPCs in groundwater, the total fruits and vegetables concentration is equal to the modeled concentration from groundwater plus either the measured non-culturally significant plant concentration when available, or the modeled concentration from soil.

[c] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	mg/L	milligrams per liter
mg/kg	milligrams per kilogram		

Table B-30
Tier I Henry Site Noncancer Hazard Calculation for a Hypothetical Future Resident - Fruits and Vegetables - Upland Soil and Groundwater

Analyte	Upland Soil Concentration[a] (mg/kg)	Groundwater Concentration[a] (mg/L)	Modeled Fruits and Vegetables Concentration from Soil (mg/kg)	Modeled Fruits and Vegetables Concentration from Groundwater (mg/kg)	Measured Non-Culturally Significant Plants Concentration (mg/kg)	Total Fruits and Vegetables Concentration [b] (mg/kg)	Plant Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [c] Oral	Chemical-Specific HQ
Antimony	9.15	NA	0.581	NA	0.176	0.176	9.2E-04	4.0E-04	**2.3**
Arsenic	45.5	0.00430	1.07	0.0193	3.47	3.49	1.8E-02	3.0E-04	**60**
Cadmium	59.5	NA	8.24	NA	1.80	1.80	9.4E-03	1.0E-03	**9.4**
Chromium	NA	0.00380	NA	0.0159	6.19	6.20	3.2E-02	1.5E+00	0.022
Cobalt	11.9	0.0100	0.220	0.0430	0.101	0.144	7.5E-04	3.0E-04	**2.5**
Manganese	2,040	3.39	155	21.6	18.6	40.2	2.1E-01	1.4E-01	**1.5**
Molybdenum	NA	0.110	NA	0.700	42.5	43.2	2.2E-01	5.0E-03	**45**
Nickel	425	NA	12.1	NA	5.92	5.92	3.1E-02	2.0E-02	**1.5**
Selenium	318	0.219	6.29	0.952	49.6	50.6	2.6E-01	5.0E-03	**53**
Thallium	2.31	0.000900	0.0335	0.00375	0.242	0.246	1.3E-03	1.0E-05	**128**
Uranium	74.4	NA	1.16	NA	0.432	0.432	2.2E-03	2.0E-04	**11**
Vanadium	584	NA	8.70	NA	4.45	4.45	2.3E-02	5.0E-03	**4.6**
								HI	**319**

Notes:

[a] Maximum detected concentration measured in fruits and vegetables samples collected from Henry Site sampling locations.

[b] For an analyte that is only a constituent of potential concern (COPC) in soil, measured non-culturally significant plant concentration, when available, was used to represent the fruits and vegetables concentration. If an analyte is a COPC in groundwater, the total fruits and vegetables concentration is equal to the modeled concentration from groundwater plus either the measured non-culturally significant plant concentration when available, or the modeled concentration from soil.

[c] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	mg/L	milligrams per liter
HQ	hazard quotient	NA	not applicable
mg/kg	milligrams per kilogram		

Table B-31
Summary of Tier I Henry Site Human Health Risk Estimates - Fruits and Vegetables - Upland Soil and Groundwater

Analyte	Upland Soil Concentration[a] (mg/kg)			Groundwater Concentration[a] (mg/L)			Modeled Total Fruits and Vegetables Concentration (mg/kg)	Measured Non-Culturally Significant Plants Concentration (mg/kg)	Hypothetical Future Resident	
	Maximum	95% UCL	EPC[b]	Maximum	95% UCL	EPC[b]	EPC[c]	EPC[d]	ILCR	HQ
Antimony	9.15	NA	9.15	NA	NA	NA	0.176	0.176	NA	**2.3**
Arsenic	45.5	NA	45.5	0.00430	NA	0.00430	3.49	3.47	**1.2E-02**	**60**
Cadmium	59.5	NA	59.5	NA	NA	NA	1.80	1.80	NA	**9.4**
Chromium	NA	NA	NA	0.00380	NA	0.00380	6.20	6.19	NA	0.022
Cobalt	11.9	NA	11.9	0.0100	NA	0.0100	0.144	0.101	NA	**2.5**
Manganese	2,040	NA	2,040	3.39	NA	3.39	40.2	18.6	NA	**1.5**
Molybdenum	NA	NA	NA	0.110	NA	0.110	43.2	42.5	NA	**45**
Nickel	425	NA	425	NA	NA	NA	5.92	5.92	NA	**1.5**
Selenium	318	NA	318	0.219	NA	0.219	50.6	49.6	NA	**53**
Thallium	2.31	NA	2.31	0.000900	NA	0.000900	0.246	0.242	NA	**128**
Uranium	74.4	NA	74.4	NA	NA	NA	0.432	0.432	NA	**11**
Vanadium	584	NA	584	NA	NA	NA	4.45	4.45	NA	**4.6**
								Cumulative ILCR/HQ:	**1E-02**	**319**
								IDEQ Point of Departure:	10^{-5}	1
								USEPA Risk Range:	10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration measured in upland soil and groundwater samples collected from Henry Site sampling locations.

[b] The soil and groundwater EPCs used to model fruits and vegetables concentrations are the maximum detected concentrations from these media.

[c] The fruits and vegetables EPC was modeled from the groundwater EPC and the measured plant EPC, where available, or the soil EPC, using plant uptake factors as described in Table B-29 and Table B-30.

[d] Maximum detected concentration measured in non-culturally significant plant samples in wet weight. The dry weight non-culturally significant data were converted to wet weight using an average moisture content of 66 percent.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
mg/L - milligrams per liter
NA - not applicable
USEPA - U. S. Environmental Protection Agency

Table B-32
Tier I Henry Site Cancer Risk Calculation for a Current/Future Native American - Elk - Upland Soil and Surface Water

Analyte	Upland Soil Concentration[a] (mg/kg)	Surface Water Concentration[a] (mg/L)	Modeled Elk Concentration from Soil (mg/kg)	Modeled Elk Concentration from Surface Water (mg/kg)	Total Elk Concentration (mg/kg)	Modeled Elk Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Chemical-Specific Risk
Arsenic	45.5	0.0224	0.00078	0.000721	0.00150	4.8E-07	1.5E+00	7.2E-07
							ILCR	7E-07

Notes:

[a] Maximum detected concentration measured in upland soil and surface water samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	mg/L	milligrams per liter
mg/kg	milligrams per kilogram		

Table B-33

Tier I Henry Site Noncancer Hazard Calculation for a Current/Future Native American - Elk - Upland Soil and Surface Water

Analyte	Upland Soil Concentration[a] (mg/kg)	Surface Water Concentration[a] (mg/L)	Modeled Elk Concentration from Soil (mg/kg)	Modeled Elk Concentration from Surface Water (mg/kg)	Total Elk Concentration (mg/kg)	Modeled Elk Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Chemical-Specific HQ
Antimony	9.15	NA	0.000286	NA	0.000286	2.1E-07	4.0E-04	0.00053
Arsenic	45.5	0.0224	0.000775	0.000721	0.00150	1.1E-06	3.0E-04	0.0037
Cadmium	59.5	0.0352	0.00242	0.000311	0.00273	2.0E-06	1.0E-03	0.0020
Chromium	NA	0.00760	NA	0.000672	0.000672	5.0E-07	1.5E+00	0.00000033
Cobalt	11.9	0.0141	0.00135	0.00454	0.00589	4.4E-06	3.0E-04	0.015
Manganese	2,040	2.4	0.0313	0.016	0.047	3.5E-05	1.4E-01	0.00025
Nickel	425	1.26	0.0290	0.122	0.151	1.1E-04	2.0E-02	0.0056
Selenium	318	0.970	0.0305	0.234	0.264	2.0E-04	5.0E-03	0.039
Thallium	2.31	0.000348	0.000315	0.000224	0.000539	4.0E-07	1.0E-05	0.040
Uranium	74.4	NA	0.0000602	NA	0.0000602	4.5E-08	2.0E-04	0.00022
Vanadium	584	0.0885	0.0053	0.00356	0.00884	6.6E-06	5.0E-03	0.0013
							HI	0.1

Notes:

[a] Maximum detected concentration measured in upland soil and surface water samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	mg/L	milligrams per liter
HQ	hazard quotient	NA	not applicable
mg/kg	milligrams per kilogram		

Table B-34
Summary of Tier I Henry Site Human Health Risk Estimates - Elk - Upland Soil and Surface Water

Analyte	Upland Soil Concentration[a] (mg/kg)			Surface Water Concentration[a] (mg/L)			Modeled Elk Concentration (mg/kg)	Current/Future Native American	
	Maximum	95% UCL	EPC[b]	Maximum	95% UCL	EPC[b]	EPC[c]	ILCR	HQ
Antimony	9.15	NA	9.15	NA	NA	NA	0.000286	NA	0.00053
Arsenic	45.5	NA	45.5	0.0224	NA	0.0224	0.00150	7.2E-07	0.0037
Cadmium	59.5	NA	59.5	0.0352	NA	0.0352	0.00273	NA	0.0020
Chromium	NA	NA	NA	0.00760	NA	0.00760	0.000672	NA	0.00000033
Cobalt	11.9	NA	11.9	0.0141	NA	0.0141	0.00589	NA	0.015
Manganese	2,040	NA	2,040	2.4	NA	2.4	0.047	NA	0.00025
Nickel	425	NA	425	1.26	NA	1.26	0.151	NA	0.0056
Selenium	318	NA	318	0.970	NA	0.970	0.264	NA	0.039
Thallium	2.31	NA	2.31	0.000348	NA	0.000348	0.000539	NA	0.040
Uranium	74.4	NA	74.4	NA	NA	NA	0.0000602	NA	0.00022
Vanadium	584	NA	584	0.0885	NA	0.0885	0.00884	NA	0.0013
Cumulative ILCR/HQ:								7E-07	0.1
IDEQ Point of Departure:								10^{-5}	1
USEPA Risk Range:								10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration measured in upland soil and surface water samples collected from Henry Site sampling locations.

[b] The upland soil and surface water EPCs used to model elk concentrations are the maximum detected concentration in those media.

[c] The elk EPC was modeled from upland soil and surface water EPCs.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk

mg/kg - milligrams per kilogarm
mg/L - milligrams per liter
NA - not applicable
USEPA - U. S. Environmental Protection Agency

Table B-35
Tier I Henry Site Cancer Risk Calculation for a Current/Future Seasonal Rancher - Cattle - Upland Soil and Surface Water

Analyte	Upland Soil Concentration[a] (mg/kg)	Surface Water Concentration (mg/L)	Modeled Cattle Concentration from Soil (mg/kg)	Modeled Cattle Concentration from Surface Water (mg/kg)	Total Cattle Concentration (mg/kg)	Modeled Cattle Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Chemical-Specific Risk
Arsenic	45.5	0.0224	0.0258	0.00237	0.0281	6.3E-05	1.5E+00	**9.4E-05**
							ILCR	**9E-05**

Notes:

[a] Maximum detected concentration measured in upland soil and surface water samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

% UCL percent upper confidence limit
ILCR incremental lifetime cancer risk
mg/kg milligrams per kilogram
mg/kg-d milligrams per kilogram per day
mg/L milligrams per liter

Table B-36
Tier I Henry Site Noncancer Hazard Calculation for a Current/Future Seasonal Rancher - Cattle - Upland Soil and Surface Water

Analyte	Upland Soil Concentration[a] (mg/kg)	Surface Water Concentration[a] (mg/L)	Modeled Cattle Concentration from Soil (mg/kg)	Modeled Cattle Concentration from Surface Water (mg/kg)	Total Cattle Concentration (mg/kg)	Modeled Cattle Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Chemical-Specific HQ
Antimony	9.15	NA	0.00825	NA	0.00825	5.4E-05	4.0E-04	0.13
Arsenic	45.5	0.0224	0.0258	0.00237	0.0281	1.8E-04	3.0E-04	0.61
Cadmium	59.5	0.0352	0.0675	0.00103	0.0685	4.5E-04	1.0E-03	0.45
Chromium	NA	0.00760	NA	0.00222	0.00222	1.4E-05	1.5E+00	0.0000096
Cobalt	11.9	0.0141	0.0489	0.0149	0.0639	4.2E-04	3.0E-04	**1.4**
Manganese	2,040	2.4	0.894	0.052	0.95	6.2E-03	1.4E-01	0.044
Nickel	425	1.26	0.919	0.401	1.32	8.6E-03	2.0E-02	0.43
Selenium	318	0.970	1.07	0.771	1.84	1.2E-02	5.0E-03	**2.4**
Thallium	2.31	0.000348	0.0133	0.000738	0.0140	9.1E-05	1.0E-05	**9.1**
Uranium	74.4	NA	0.00240	NA	0.00240	1.6E-05	2.0E-04	0.078
Vanadium	584	0.0885	0.218	0.0117	0.230	1.5E-03	5.0E-03	0.30
							HI	**15**

Notes:
[a] Maximum detected concentration measured in upland soil and surface water samples collected from Henry Site sampling locations.
[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	mg/L	milligrams per liter
HQ	hazard quotient	NA	not applicable
mg/kg	milligrams per kilogram		

Table B-37
Summary of Tier I Henry Site Human Health Risk Estimates - Cattle - Upland Soil and Surface Water

Analyte	Upland Soil Concentration[a] (mg/kg)			Surface Water Concentration[a] (mg/L)			Modeled Cattle Concentration (mg/kg)	Current/Future Seasonal Rancher	
	Maximum	95% UCL	EPC[b]	Maximum	95% UCL	EPC[b]	EPC[c]	ILCR	HQ
Antimony	9.15	NA	9.15	NA	NA	NA	0.00825	NA	0.13
Arsenic	45.5	NA	45.5	0.0224	NA	0.0224	0.0281	**9.4E-05**	0.61
Cadmium	59.5	NA	59.5	0.0352	NA	0.0352	0.0685	NA	0.45
Chromium	NA	NA	NA	0.00760	NA	0.00760	0.00222	NA	0.0000096
Cobalt	11.9	NA	11.9	0.0141	NA	0.0141	0.0639	NA	**1.4**
Manganese	2,040	NA	2,040	2.4	NA	2.4	0.95	NA	0.044
Nickel	425	NA	425	1.26	NA	1.26	1.32	NA	0.43
Selenium	318	NA	318	0.970	NA	0.970	1.84	NA	**2.4**
Thallium	2.31	NA	2.31	0.000348	NA	0.000348	0.0140	NA	**9.1**
Uranium	74.4	NA	74.4	NA	NA	NA	0.00240	NA	0.078
Vanadium	584	NA	584	0.0885	NA	0.0885	0.230	NA	0.30
Cumulative ILCR/HQ:								**9E-05**	**15**
IDEQ Point of Departure:								10^{-5}	1
USEPA Risk Range:								10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration measured in upland soil and surface water samples collected from Henry Site sampling locations.

[b] The upland soil and groundwater EPCs used to model cattle concentration are the maximum detected concentrations in those media.

[d] The cattle EPC was modeled from upland soil and surface water EPCs.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk

mg/kg - milligrams per kilogarm
mg/L - milligrams per liter
NA - not applicable
USEPA - U. S. Environmental Protection Agency

Table B-38
Tier I Henry Site Cancer Risk Calculation for a Current/Future Seasonal Rancher - Cattle - Upland Soil and Groundwater

Analyte	Upland Soil Concentration[a] (mg/kg)	Groundwater Concentration (mg/L)	Modeled Cattle Concentration from Soil (mg/kg)	Modeled Cattle Concentration from Groundwater (mg/kg)	Total Cattle Concentration (mg/kg)	Modeled Cattle Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Chemical-Specific Risk
Arsenic	45.5	0.00430	0.0258	0.000456	0.0262	5.9E-05	1.5E+00	**8.8E-05**
							ILCR	**9E-05**

Notes:

[a] Maximum detected concentration measured in upland soil and groundwater samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	mg/L	milligrams per liter
mg/kg	milligrams per kilogram		

Table B-39
Tier I Henry Site Noncancer Hazard Calculation for a Current/Future Seasonal Rancher - Cattle - Upland Soil and Groundwater

Analyte	Upland Soil Concentration[a] (mg/kg)	Groundwater Concentration[a] (mg/L)	Modeled Cattle Concentration from Soil (mg/kg)	Modeled Cattle Concentration from Groundwater (mg/kg)	Total Cattle Concentration (mg/kg)	Modeled Cattle Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Chemical-Specific HQ
Antimony	9.15	NA	0.00825	NA	0.00825	5.4E-05	4.0E-04	0.13
Arsenic	45.5	0.00430	0.0258	0.000456	0.0262	1.7E-04	3.0E-04	0.57
Cadmium	59.5	NA	0.0675	NA	0.0675	4.4E-04	1.0E-03	0.44
Chromium	NA	0.00380	NA	0.00111	0.00111	7.2E-06	1.5E+00	0.0000048
Cobalt	11.9	0.0100	0.0489	0.0106	0.0595	3.9E-04	3.0E-04	**1.3**
Manganese	2,040	3.39	0.894	0.0719	0.966	6.3E-03	1.4E-01	0.045
Molybdenum	NA	0.110	NA	0.0350	0.0350	2.3E-04	5.0E-03	0.046
Nickel	425	NA	0.919	NA	0.919	6.0E-03	2.0E-02	0.30
Selenium	318	0.219	1.07	0.174	1.25	8.1E-03	5.0E-03	**1.6**
Thallium	2.31	0.000900	0.0133	0.00191	0.0152	9.9E-05	1.0E-05	**9.9**
Uranium	74.4	NA	0.00240	NA	0.00240	1.6E-05	2.0E-04	0.078
Vanadium	584	NA	0.218	NA	0.218	1.4E-03	5.0E-03	0.28
							HI	**15**

Notes:

[a] Maximum detected concentration measured in upland soil and groundwater samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	mg/L	milligrams per liter
HQ	hazard quotient	NA	not applicable
mg/kg	milligrams per kilogram		

Table B-40
Summary of Tier I Henry Site Human Health Risk Estimates - Cattle - Upland Soil and Groundwater

Analyte	Upland Soil Concentration[a] (mg/kg)			Groundwater Concentration[a] (mg/L)			Modeled Cattle Concentration (mg/kg)	Current/Future Seasonal Rancher	
	Maximum	95% UCL	EPC[b]	Maximum	95% UCL	EPC[b]	EPC[c]	ILCR	HQ
Antimony	9.15	NA	9.15	NA	NA	NA	0.00825	NA	0.13
Arsenic	45.5	NA	45.5	0.00430	NA	0.00430	0.0262	**8.8E-05**	0.57
Cadmium	59.5	NA	59.5	NA	NA	NA	0.0675	NA	0.44
Chromium	NA	NA	NA	0.00380	NA	0.00380	0.00111	NA	0.0000048
Cobalt	11.9	NA	11.9	0.0100	NA	0.0100	0.0595	NA	**1.3**
Manganese	2,040	NA	2,040	3.39	NA	3.39	0.966	NA	0.045
Molybdenum	NA	NA	NA	0.110	NA	0.110	0.0350	NA	0.046
Nickel	425	NA	425	NA	NA	NA	0.919	NA	0.30
Selenium	318	NA	318	0.219	NA	0.219	1.25	NA	**1.6**
Thallium	2.31	NA	2.31	0.000900	NA	0.000900	0.0152	NA	**9.9**
Uranium	74.4	NA	74.4	NA	NA	NA	0.00240	NA	0.078
Vanadium	584	NA	584	NA	NA	NA	0.218	NA	0.28
Cumulative ILCR/HQ:								**9E-05**	**15**
IDEQ Point of Departure:								10^{-5}	1
USEPA Risk Range:								10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration measured in upland soil and groundwater samples collected from Henry Site sampling locations.

[b] The upland soil and groundwater EPCs used to model cattle concentration are the maximum detected concentrations in those media.

[d] The cattle EPC was modeled from upland soil and groundwater EPCs.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
mg/L - milligrams per liter
NA - not applicable
USEPA - U. S. Environmental Protection Agency

Table B-41
Tier I Henry Site Cancer Risk Calculation for a Current/Future Native American - Culturally Significant Aquatic Plants

Analyte	Sediment Concentration[a] (mg/kg)	Surface Water Concentration[a] (mg/L)	Modeled Culturally Significant Aquatic Plant Concentration from Sediment (mg/kg dry weight)	Modeled Culturally Significant Aquatic Plant Concentration from Sediment [b] (mg/kg wet weight)	Modeled Plant Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [c] Oral	Chemical-Specific Risk
Arsenic	10.6	0.0224	0.398	0.136	3.0E-04	1.5E+00	**4.6E-04**
						ILCR	**5E-04**

Notes:

[a] Maximum detected concentration measured in sediment or surface water samples collected from Henry Site sampling locations.

[b] Dry weight plant concentrations were converted to wet weight plant concentrations assuming a plant moisture content of 65.7 percent.

[c] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

95% UCL 95 percent upper confidence limit
ILCR incremental lifetime cancer risk
mg/kg milligrams per kilogram
mg/kg-d milligrams per kilogram per day
mg/L milligrams per liter

Table B-42
Tier I Henry Site Noncancer Hazard Calculation for a Current/Future Native American - Culturally Significant Aquatic Plants

Analyte	Sediment Concentration[a] (mg/kg)	Surface Water Concentration (mg/L)	Modeled Culturally Significant Aquatic Plant Concentration from Sediment (mg/kg dry weight)	Modeled Culturally Significant Aquatic Plant Concentration from Sediment [b] (mg/kg wet weight)	Modeled Plant Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [c] Oral	Chemical-Specific HQ
Antimony	8.50	0.00230	0.294	0.101	5.2E-04	4.0E-04	**1.3**
Arsenic	10.6	0.0224	0.398	0.136	7.1E-04	3.0E-04	**2.4**
Cadmium	104	0.0352	7.85	2.69	1.4E-02	1.0E-03	**14**
Chromium	1,030	0.00760	42.2	14.5	7.5E-02	1.5E+00	0.050
Cobalt	10.6	0.0141	0.08	0.027	1.4E-04	3.0E-04	0.47
Manganese	2,580	2.4	204	69.8	3.6E-01	1.4E-01	**2.6**
Nickel	1,110	1.26	20.5	7.03	3.7E-02	2.0E-02	**1.8**
Selenium	148	0.970	126	43.3	2.3E-01	5.0E-03	**45**
Thallium	2.17	0.000348	0.00868	0.00297	1.5E-05	1.0E-05	**1.5**
Uranium	90.0	NA	0.765	0.262	1.4E-03	2.0E-04	**6.8**
Vanadium	940	0.0885	4.6	1.56	8.1E-03	5.0E-03	**1.6**
Zinc	7,940	4.73	699	239	1.2E+00	3.0E-01	**4.2**
						HI	**82**

Notes:

[a] Maximum detected concentration measured in sediment or surface water samples collected from Henry Site sampling locations.

[b] Dry weight plant concentrations were converted to wet weight plant concentrations assuming a plant moisture content of 65.7 percent.

[c] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

95% UCL	95 percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	mg/L	milligrams per liter
HQ	hazard quotient	NA	not applicable
mg/kg	milligrams per kilogram		

Table B-43
Summary of Tier I Henry Site Human Health Risk Estimates - Culturally Significant Aquatic Plants

Analyte	Sediment Concentration[a] (mg/kg)			Surface Water Concentration[a] (mg/L)			Modeled Culturally Significant Aquatic Plants Concentration (mg/kg)	Current/Future Native American	
	Maximum	95% UCL	EPC[b]	Maximum	95% UCL	EPC	EPC[c]	ILCR	HQ
Antimony	8.50	NA	8.50	0.00230	NA	0.00230	0.101	NA	**1.3**
Arsenic	10.6	NA	10.6	0.0224	NA	0.0224	0.136	**4.6E-04**	**2.4**
Cadmium	104	NA	104	0.0352	NA	0.0352	2.69	NA	**14**
Chromium	1,030	NA	1,030	0.00760	NA	0.00760	14.5	NA	0.050
Cobalt	10.6	NA	10.60	0.0141	NA	0.01410	0.0272	NA	0.47
Manganese	2,580	NA	2,580	2.4	NA	2.4	69.8	NA	**2.6**
Nickel	1,110	NA	1,110	1.26	NA	1.26	7.03	NA	**1.8**
Selenium	148	NA	148	0.970	NA	0.970	43.3	NA	**45**
Thallium	2.17	NA	2.17	0.000348	NA	0.000348	0.00297	NA	**1.5**
Uranium	90.0	NA	90.0	NA	NA	NA	0.262	NA	**6.8**
Vanadium	940	NA	940	0.0885	NA	0.08850	1.56	NA	**1.6**
Zinc	7,940	NA	7,940	4.73	NA	4.73	239	NA	**4.2**
Cumulative ILCR/HQ:								**5E-04**	**82**
IDEQ Point of Departure:								10^{-5}	1
USEPA Risk Range:								10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration measured in sediment or surface water samples collected from Henry Site sampling locations.

[b] The sediment EPC used to model culturally significant aquatic plants concentration is the maximum detected concentration.

[c] The culturally significant aquatic plants EPCs for surface water constituents of potential concern were modeled from the sediment EPCs using sediment-to-plant uptake factors when sediment data were available.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
mg/L - milligrams per liter
NA - not applicable
USEPA - U. S. Environmental Protection Agency

Table B-44
Tier I Henry Site Cancer Risk Calculation - Fish
Recreational Fisher, Native American and Hypothetical Future Resident

Analyte	Sediment Concentration[a] (mg/kg)	Surface Water Concentration[a] (mg/L)	Modeled Fish Concentration from Sediment (mg/kg wet weight)	Modeled Fish Concentration from Surface Water (mg/kg wet weight)	Fish Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Chemical-Specific Risk
Arsenic	10.6	0.02240	0.0254	2.554	5.6E-04	1.5E+00	**8.3E-04**
						ILCR	**8E-04**

Notes:

[a] Maximum detected concentration measured in sediment or surface water samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

95% UCL	95 percent upper confidence limit
ILCR	incremental lifetime cancer risk
mg/kg	milligrams per kilogram
mg/kg-d	milligrams per kilogram per day
mg/L	milligrams per liter

Table B-45
Tier I Henry Site Noncancer Hazard Calculation - Fish
Recreational Fisher, Native American and Hypothetical Future Resident

Analyte	Sediment Concentration[a] (mg/kg)	Surface Water Concentration (mg/L)	Modeled Fish Concentration from Sediment (mg/kg wet weight)	Modeled Fish Concentration from Surface Water (mg/kg wet weight)	Fish Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Chemical-Specific HQ
Antimony	8.50	0.00230	8.50	0.0920	4.7E-05	4.0E-04	0.12
Arsenic	10.6	0.0224	0.0254	2.55	1.3E-03	3.0E-04	**4.3**
Cadmium	104	0.0352	16.3	31.9	1.6E-02	1.0E-03	**16**
Chromium	1,030	0.00760	8.86	0.144	7.3E-05	1.5E+00	0.000049
Cobalt	10.6	0.0141	10.6	0.0141	7.2E-06	3.0E-04	0.024
Manganese	2,580	2.4	2,580	2.4	1.2E-03	1.4E-01	0.009
Nickel	1,110	1.26	1,110	98.3	5.0E-02	2.0E-02	**2.5**
Selenium	148	0.970	148	125	6.4E-02	5.0E-03	**13**
Thallium	2.17	0.000348	2.17	3.48	1.8E-03	1.0E-05	**177**
Uranium	90.0	0.0206	90.0	0.0206	1.0E-05	2.0E-04	0.052
Vanadium	940	0.0885	940	0.0885	4.5E-05	5.0E-03	0.0090
Zinc	7,940	4.73	2,911	9,739	5.0E+00	3.0E-01	**17**
						HI	**229**

Notes:

[a] Maximum detected concentration measured in sediment or surface water samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

95% UCL	95 percent upper confidence limit	mg/kg	milligrams per kilogram
HI	hazard index	mg/kg-d	milligrams per kilogram per day
HQ	hazard quotient	mg/L	milligrams per liter

Table B-46
Summary of Tier I Henry Site Human Health Risk Estimates - Fish

Analyte	Sediment Concentration[a] (mg/kg)			Surface Water Concentration[a] (mg/L)			Modeled Fish Concentration (mg/kg)	Current/Future Recreational Fisher and Native American and Hypothetical Future Resident	
	Maximum	95% UCL	EPC[b]	Maximum	95% UCL	EPC[b]	EPC[c]	ILCR	HQ
Antimony	8.50	NA	8.50	0.00230	NA	0.00230	0.0920	NA	0.12
Arsenic	10.6	NA	10.6	0.0224	NA	0.0224	2.55	**8.3E-04**	**4.3**
Cadmium	104	NA	104	0.0352	NA	0.0352	31.9	NA	**16**
Chromium	1,030	NA	1,030	0.00760	NA	0.00760	0.144	NA	0.000049
Cobalt	10.6	NA	10.6	0.0141	NA	0.0141	0.0141	NA	0.024
Manganese	2,580	NA	2,580	2.4	NA	2.4	2.4	NA	0.009
Nickel	1,110	NA	1,110	1.26	NA	1.26	98.3	NA	**2.5**
Selenium	148	NA	148	0.970	NA	0.970	125	NA	**13**
Thallium	2.17	NA	2.17	0.000348	NA	0.000348	3.48	NA	**177**
Uranium	90.0	NA	90.0	0.0206	NA	0.0206	0.0206	NA	0.052
Vanadium	940	NA	940	0.0885	NA	0.0885	0.0885	NA	0.0090
Zinc	7,940	NA	7,940	4.73	NA	4.73	9,739	NA	**17**
Cumulative ILCR/HQ:								**8E-04**	**229**
IDEQ Point of Departure:								10^{-5}	1
USEPA Risk Range:								10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration measured in sediment or surface water samples collected from Henry Site sampling locations.

[b] The sediment or surface water EPC used to model the fish concentration is the maximum detected concentration.

[c] The fish EPCs for both surface water and sediment constituents of potential concern were modeled from the surface water EPCs using surface water-to-fish uptake factors when surface water data were available, otherwise they were modeled from the sediment EPCs using sediment-to-fish uptake factors.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
mg/L - milligrams per liter
NA - not applicable
USEPA - U. S. Environmental Protection Agency

Table B-47

Tier I Henry Site Radiological Risk Calculation for a Current/Future Native American

Medium	Radium-226 EPC[a]		Pathway-Specific Radium-226 PRG [b]		Pathway-Specific Radium-226 Risk	Total Medium Radium-226 Risk
Culturally Significant Plants						
Upland Soil	58.8	pCi/g	0.0248	pCi/g	**2.4E-03**	**2.4E-03**
Elk						
Upland Soil	58.8	pCi/g	57	pCi/g	1.0E-06	1.0E-06
Upland Soil						
Incidental Ingestion	58.8	pCi/g	1.53	pCi/g	**3.8E-05**	**9.4E-04**
External Exposure	58.8	pCi/g	0.0650	pCi/g	**9.0E-04**	
Inhalation of Particulates	58.8	pCi/g	19,400	pCi/g	3.0E-09	
Aquatic Plants [c]						
Sediment	62.6	pCi/g	0.0474	pCi/g	**1.3E-03**	**1.3E-03**
Fish						
Surface Water	7.17	pCi/L	1.71	pCi/L	**4.2E-06**	**4.2E-06**
					Total Site Media Risk:	**3E-03**
					IDEQ Point-of-departure:	**10^{-5}**
					USEPA Risk Range:	**10^{-6} - 10^{-4}**

Notes:

[a] The upland soil EPC was calculated from gamma count measurements at the Henry Site according to the regression model described in the on-site and background areas radiological and soil investigation summary report (MWH, 2015). The surface water EPC was calculated from total uranium based on an assumption of secular equilibrium (i.e., 1 pCi/L uranium-238 is equivalent to 1 pCi/L radium-226), a natural abundance of uranium-238 of 49% of total uranium (ATSDR, 2013), and a unit conversion of 7.1×10^5 pCi/g based on the activity of natural uranium (49 CFR 173.434). The sediment EPC was calculated based on the same total uranium to radium-226 conversion factor used to calculate water EPCs, with an additional uranium-238 to radium-226 ratio of 0.5 to 1, based on the approximate mean ratio for upland soils described in MWH (2015), applied.

[b] Preliminary Remediation Goals (PRGs) for radium-226+daughter products were calculated using the USEPA's online PRG calculator for radionuclides.

[c] Consistent with the evaluation for metals, the cumulative ILCR for the Native American includes the larger of the ILCR for radium-226 in upland or aquatic culturally significant plants. Because the PRG for aquatic plants is greater than the PRG for upland plants, aquatic plants are not included in the cumulative ILCR.

Bold indicates ILCR estimates above USEPA's risk management range or IDEQ's point of departure

EPC - Exposure point concentration
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
pCi/g - picocuries per gram
pCi/L - picocuries per liter
PRG - Preliminary Remediation Goal
USEPA - United States Environmental Protection Agency

Table B-48

Tier I Henry Site Radiological Risk Calculation for a Hypothetical Future Resident

Medium	Radium-226 EPC[a]		Pathway-Specific Radium-226 PRG [b]		Pathway-Specific Radium-226 Risk	Total Medium Radium-226 Risk
Fruits and Vegetables						
Upland Soil	58.8	pCi/g	0.0248	pCi/g	**2.4E-03**	**2.4E-03**
Upland Soil						
Incidental Ingestion	58.8	pCi/g	1.53	pCi/g	**3.8E-05**	**9.4E-04**
External Exposure	58.8	pCi/g	0.0650	pCi/g	**9.0E-04**	
Inhalation of Particulates	58.8	pCi/g	19,400	pCi/g	3.0E-09	
Fish						
Surface Water	7.17	pCi/L	1.71	pCi/L	**4.2E-06**	**4.2E-06**
Medium	**Radon-222 EPC[a]**		**Pathway-Specific Radon-222 PRG [b]**		**Pathway-Specific Radon-222 Risk**	**Total Medium Radon-222 Risk**
Indoor Air	13,327	pCi/m^3	0.242	pCi/m^3	**5.5E-02**	**5.5E-02**
					Total Site Media Risk:	**6E-02**
					IDEQ Point-of-departure:	**10^{-5}**
					USEPA Risk Range:	**10^{-6} - 10^{-4}**

Notes:

[a] The upland soil EPC was calculated from gamma count measurements at the Henry Site according to the regression model described in the on-site and background areas radiological and soil investigation summary report (MWH, 2015). The surface water EPC was calculated from total uranium based on an assumption of secular equilibrium (i.e., 1 pCi/L uranium-238 is equivalent to 1 pCi/L radium-226), a natural abundance of uranium-238 of 49% of total uranium (ATSDR, 2013), and a unit conversion of 7.1x105 pCi/g based on the activity of natural uranium (49 CFR 173.434). The indoor air EPC was calculated from radon flux measurements from background sample locations (MWH, 2015).

[b] Preliminary Remediation Goals (PRGs) for radium-226+daughter products and radon-222+daughter products were calculated using the USEPA's online PRG calculator for radionuclides.

Bold indicates ILCR estimates above USEPA's risk management range or IDEQ's point of departure

EPC - Exposure point concentration
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
NA - not applicable
pCi/g - picocuries per gram
pCi/L - picocuries per liter
PRG - Preliminary Remediation Goal
USEPA - United States Environmental Protection Agency

Table B-49

Tier I Henry Site Radiological Risk Calculation for a Current/Future Seasonal Rancher

Medium	Radium-226 EPC[a]		Pathway-Specific Radium-226 PRG [b]		Pathway-Specific Radium-226 Risk	Total Medium Radium-226 Risk
Cattle						
Upland Soil	58.8	pCi/g	0.631	pCi/g	**9.3E-05**	**9.3E-05**
Upland Soil						
Incidental Ingestion	58.8	pCi/g	5.15	pCi/g	**1.1E-05**	**1.9E-03**
External Exposure	58.8	pCi/g	0.0304	pCi/g	**1.9E-03**	
Inhalation of Particulates	58.8	pCi/g	8,190	pCi/g	7.2E-09	
					Total Site Media Risk:	**2E-03**
					IDEQ Point-of-departure:	**10^{-5}**
					USEPA Risk Range:	**10^{-6} - 10^{-4}**

Notes:

[a] The upland soil EPC was calculated from gamma count measurements at the Henry Site according to the regression model described in the on-site and background areas radiological and soil investigation summary report (MWH, 2015).

[b] Preliminary Remediation Goals (PRGs) for radium-226+daughter products were calculated using the USEPA's online PRG calculator for radionuclides.

Bold indicates ILCR estimates above USEPA's risk management range or IDEQ's point of departure

EPC - Exposure point concentration
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
NA - not applicable
pCi/g - picocuries per gram
pCi/L - picocuries per liter
PRG - Preliminary Remediation Goal
USEPA - United States Environmental Protection Agency

ATTACHMENT C – TIER I BACKGROUND HUMAN HEALTH RISK CALCULATIONS

Table C-1
Tier I Background Cancer Risk Calculation for a Current/Future Native American - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Dust Inhalation Dose (ug/m^3)	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b]		URF (ug/m^3)$^{-1}$ [b]	Pathway-Specific Cancer Risk			Chemical-Specific Risk
					Oral	Dermal	Inhalation	Soil Ingestion	Dermal	Dust Inhalation	
Arsenic	19.0	1.4E-05	1.0E-05	7.8E-08	1.5E+00	1.5E+00	4.3E-03	2.1E-05	1.5E-05	3.3E-10	**3.6E-05**
Cadmium	44.0	5.3E-05	7.2E-07	1.8E-07	na	na	1.8E-03	na	na	3.2E-10	3.2E-10
Cobalt	13.3	1.6E-05	2.2E-06	5.4E-08	na	na	9.0E-03	na	na	4.9E-10	4.9E-10
Nickel	230	2.8E-04	3.8E-05	9.4E-07	na	na	2.6E-04	na	na	2.4E-10	2.4E-10
										ILCR	**4E-05**

Notes:

[a] Maximum detected concentration measured in upland soil samples collected from background sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL percent upper confidence limit
ILCR incremental lifetime cancer risk
mg/kg milligrams per kilogram
mg/kg-d milligrams per kilogram per day
na not available
URF unit risk factor
ug/m^3 microgram per cubic meter

Table C-2
Tier I Background Noncancer Hazard Calculation for a Current/Future Native American - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Dust Inhalation Dose (mg/m^3)	Reference Dose (mg/kg-d) [b] Oral	Reference Dose (mg/kg-d) [b] Dermal	RfC (mg/m^3) [b] Inhalation	Pathway-Specific Hazard Soil Ingestion	Pathway-Specific Hazard Dermal	Pathway-Specific Hazard Dust Inhalation	Chemical-Specific HQ
Antimony	3.60	1.0E-05	1.4E-06	3.4E-11	4.0E-04	6.0E-05	na	2.5E-02	2.3E-02	na	0.048
Arsenic	19.0	3.2E-05	2.3E-05	1.8E-10	3.0E-04	3.0E-04	1.5E-05	1.1E-01	7.8E-02	1.2E-05	0.18
Cadmium	44.0	1.2E-04	1.7E-06	4.2E-10	1.0E-03	2.5E-05	1.0E-05	1.2E-01	6.8E-02	4.2E-05	0.19
Cobalt	13.3	3.7E-05	5.1E-06	1.3E-10	3.0E-04	3.0E-04	6.0E-06	1.2E-01	1.7E-02	2.1E-05	0.14
Manganese	3,990	1.1E-02	1.5E-03	3.8E-08	1.4E-01	5.6E-03	5.0E-05	8.0E-02	2.7E-01	7.6E-04	0.35
Nickel	230	6.5E-04	8.8E-05	2.2E-09	2.0E-02	8.0E-04	9.0E-05	3.2E-02	1.1E-01	2.4E-05	0.14
Selenium	29.0	8.2E-05	1.1E-05	2.8E-10	5.0E-03	1.5E-03	2.0E-02	1.6E-02	7.4E-03	1.4E-08	0.024
Thallium	1.30	3.7E-06	5.0E-07	1.2E-11	1.0E-05	1.0E-05	na	3.7E-01	5.0E-02	na	0.42
Uranium	42.0	1.2E-04	1.6E-05	4.0E-10	2.0E-04	2.0E-04	4.0E-05	5.9E-01	8.1E-02	1.0E-05	0.67
Vanadium	370	1.0E-03	1.4E-04	3.5E-09	5.0E-03	1.3E-04	1.0E-04	2.1E-01	1.1E+00	3.5E-05	**1.3**
										HI	**3**

Notes:
[a] Maximum detected concentration measured in upland soil samples collected from background sampling locations.
[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	mg/m^3	milligram per cubic meter
HQ	hazard quotient	na	not available

Table C-3
Tier I Background Cancer Risk Calculation for a Hypothetical Future Resident - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Inhalation Dose (ug/m^3)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b]		URF $(ug/m^3)^{-1}$ [b]	Pathway-Specific Cancer Risk			Chemical-Specific Risk
					Oral	Dermal	Inhalation	Soil Ingestion	Dermal	Inhalation	
Arsenic	19.0	1.4E-05	1.0E-05	7.8E-08	1.5E+00	1.5E+00	4.3E-03	2.1E-05	1.5E-05	3.3E-10	**3.6E-05**
Cadmium	44.0	5.3E-05	7.2E-07	1.8E-07	na	na	1.8E-03	na	na	3.2E-10	3.2E-10
Cobalt	13.3	1.6E-05	2.2E-06	5.4E-08	na	na	9.0E-03	na	na	4.9E-10	4.9E-10
Nickel	230	2.8E-04	3.8E-05	9.4E-07	na	na	2.6E-04	na	na	2.4E-10	2.4E-10
										ILCR	**4E-05**

Notes:

[a] Maximum detected concentration measured in upland soil samples collected from background sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL	percent upper confidence limit	na	not available
ILCR	incremental lifetime cancer risk	URF	unit risk factor
mg/kg	milligrams per kilogram	ug/m^3	microgram per cubic meter
mg/kg-d	milligrams per kilogram per day		

Table C-4
Tier I Background Noncancer Hazard Calculation for a Hypothetical Future Resident - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Inhalation Dose (mg/m^3)	Reference Dose (mg/kg-d) [b]		RfC (mg/m^3) [b]	Pathway-Specific Hazard			Chemical-Specific HQ
					Oral	Dermal	Inhalation	Soil Ingestion	Dermal	Inhalation	
Antimony	3.60	1.0E-05	1.4E-06	3.4E-11	4.0E-04	6.0E-05	na	2.5E-02	2.3E-02	na	0.048
Arsenic	19.0	3.2E-05	2.3E-05	1.8E-10	3.0E-04	3.0E-04	1.5E-05	1.1E-01	7.8E-02	1.2E-05	0.18
Cadmium	44.0	1.2E-04	1.7E-06	4.2E-10	1.0E-03	2.5E-05	1.0E-05	1.2E-01	6.8E-02	4.2E-05	0.19
Cobalt	13.3	3.7E-05	5.1E-06	1.3E-10	3.0E-04	3.0E-04	6.0E-06	1.2E-01	1.7E-02	2.1E-05	0.14
Manganese	3,990	1.1E-02	1.5E-03	3.8E-08	1.4E-01	5.6E-03	5.0E-05	8.0E-02	2.7E-01	7.6E-04	0.35
Nickel	230	6.5E-04	8.8E-05	2.2E-09	2.0E-02	8.0E-04	9.0E-05	3.2E-02	1.1E-01	2.4E-05	0.14
Selenium	29.0	8.2E-05	1.1E-05	2.8E-10	5.0E-03	1.5E-03	2.0E-02	1.6E-02	7.4E-03	1.4E-08	0.024
Thallium	1.30	3.7E-06	5.0E-07	1.2E-11	1.0E-05	1.0E-05	na	3.7E-01	5.0E-02	na	0.42
Uranium	42.0	1.2E-04	1.6E-05	4.0E-10	2.0E-04	2.0E-04	4.0E-05	5.9E-01	8.1E-02	1.0E-05	0.67
Vanadium	370	1.0E-03	1.4E-04	3.5E-09	5.0E-03	1.3E-04	1.0E-04	2.1E-01	1.1E+00	3.5E-05	**1.3**
										HI	**3**

Notes:

[a] Maximum detected concentration measured in upland soil samples collected from background sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	mg/m^3	milligram per cubic meter
HQ	hazard quotient	na	not available
mg/kg	milligrams per kilogram	RfC	reference concentration

Table C-5
Tier I Background Cancer Risk Calculation for a Current/Future Seasonal Rancher - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Dust Inhalation Dose (ug/m^3)	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b] Oral	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b] Dermal	URF (ug/m^3)$^{-1}$ [b] Inhalation	Pathway-Specific Cancer Risk Soil Ingestion	Pathway-Specific Cancer Risk Dermal	Pathway-Specific Cancer Risk Dust Inhalation	Chemical-Specific Risk
Arsenic	19.0	1.8E-06	2.2E-06	1.7E-07	1.5E+00	1.5E+00	4.3E-03	2.8E-06	3.3E-06	7.1E-10	**6.1E-06**
Cadmium	44.0	7.1E-06	1.6E-07	3.8E-07	na	na	1.8E-03	na	na	6.9E-10	6.9E-10
Cobalt	13.3	2.1E-06	4.8E-07	1.2E-07	na	na	9.0E-03	na	na	1.0E-09	1.0E-09
Nickel	230	3.7E-05	8.4E-06	2.0E-06	na	na	2.6E-04	na	na	5.2E-10	5.2E-10
										ILCR	**6E-06**

Notes:

[a] Maximum detected concentration measured in upland soil samples collected from background sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL percent upper confidence limit
ILCR incremental lifetime cancer risk
mg/kg milligrams per kilogram
mg/kg-d milligrams per kilogram per day
na not available
URF unit risk factor
ug/m^3 microgram per cubic meter

Table C-6
Tier I Background Noncancer Hazard Calculation for a Current/Future Seasonal Rancher - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Dust Inhalation Dose (mg/m³)	Reference Dose (mg/kg-d) [b] Oral	Reference Dose (mg/kg-d) [b] Dermal	RfC (mg/m³) [b] Inhalation	Pathway-Specific Hazard Soil Ingestion	Pathway-Specific Hazard Dermal	Pathway-Specific Hazard Dust Inhalation	Chemical-Specific HQ
Antimony	3.60	1.7E-06	3.8E-07	9.2E-11	4.0E-04	6.0E-05	na	4.2E-03	6.4E-03	na	0.011
Arsenic	19.0	5.4E-06	6.5E-06	4.8E-10	3.0E-04	3.0E-04	1.5E-05	1.8E-02	2.2E-02	3.2E-05	0.039
Cadmium	44.0	2.1E-05	4.7E-07	1.1E-09	1.0E-03	2.5E-05	1.0E-05	2.1E-02	1.9E-02	1.1E-04	0.039
Cobalt	13.3	6.2E-06	1.4E-06	3.4E-10	3.0E-04	3.0E-04	6.0E-06	2.1E-02	4.7E-03	5.6E-05	0.026
Manganese	3,990	1.9E-03	4.2E-04	1.0E-07	1.4E-01	5.6E-03	5.0E-05	1.3E-02	7.6E-02	2.0E-03	0.091
Nickel	230	1.1E-04	2.4E-05	5.9E-09	2.0E-02	8.0E-04	9.0E-05	5.4E-03	3.1E-02	6.5E-05	0.036
Selenium	29.0	1.4E-05	3.1E-06	7.4E-10	5.0E-03	1.5E-03	2.0E-02	2.7E-03	2.1E-03	3.7E-08	0.0048
Thallium	1.30	6.1E-07	1.4E-07	3.3E-11	1.0E-05	1.0E-05	na	6.1E-02	1.4E-02	na	0.075
Uranium	42.0	2.0E-05	4.5E-06	1.1E-09	2.0E-04	2.0E-04	4.0E-05	9.9E-02	2.2E-02	2.7E-05	0.12
Vanadium	370	1.7E-04	3.9E-05	9.4E-09	5.0E-03	1.3E-04	1.0E-04	3.5E-02	3.0E-01	9.4E-05	0.34
										HI	0.8

Notes:
[a] Maximum detected concentration measured in upland soil samples collected from background sampling locations.
[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	mg/m^3	milligram per cubic meter
HQ	hazard quotient	na	not available
mg/kg	milligrams per kilogram	RfC	reference concentration

Table C-7
Summary of Tier I Background Human Health Risk Estimates - Upland Soil

Analyte	Concentration[a] (mg/kg)			Current/Future Native American		Hypothetical Future Resident		Current/Future Seasonal Rancher	
	Maximum	**95% UCL**	**EPC[b]**	**ILCR**	**HQ**	**ILCR**	**HQ**	**ILCR**	**HQ**
Antimony	3.60	NA	3.60	NA	0.048	NA	0.048	NA	0.011
Arsenic	19.0	NA	19.0	**3.6E-05**	0.18	**3.6E-05**	0.18	**6.1E-06**	0.039
Cadmium	44.0	NA	44.0	3.2E-10	0.19	3.2E-10	0.19	6.9E-10	0.039
Cobalt	13.3	NA	13.3	4.9E-10	0.14	4.9E-10	0.14	1.0E-09	0.026
Manganese	3,990	NA	3,990	NA	0.35	NA	0.35	NA	0.091
Nickel	230	NA	230	2.4E-10	0.14	2.4E-10	0.14	5.2E-10	0.036
Selenium	29.0	NA	29.0	NA	0.024	NA	0.024	NA	0.0048
Thallium	1.30	NA	1.30	NA	0.42	NA	0.42	NA	0.075
Uranium	42.0	NA	42.0	NA	0.67	NA	0.67	NA	0.12
Vanadium	370	NA	370	NA	**1.3**	NA	**1.3**	NA	0.34
Cumulative ILCR/HQ:				**4E-05**	**3**	**4E-05**	**3**	**6E-06**	0.8
IDEQ Point of Departure:				10^{-5}	1				
USEPA Risk Range:				10^{-6} - 10^{-4}	1				

Notes:

[a] Maximum detected concentration measured in upland soil samples collected from background sampling locations.

[b] The exposure point concentration (EPC) is the maximum detected concentration.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
NA - not applicable
USEPA - U. S. Environmental Protection Agency

Table C-8
Tier I Background Cancer Risk Calculation for a Current/Future Native American - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Dust Inhalation Dose (ug/m^3)	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b]		URF (ug/m^3)$^{-1}$ [b]	Pathway-Specific Cancer Risk			Chemical-Specific Risk
					Oral	Dermal	Inhalation	Soil Ingestion	Dermal	Dust Inhalation	
Arsenic	5.44	3.9E-06	2.9E-06	2.2E-08	1.5E+00	1.5E+00	4.3E-03	5.9E-06	4.3E-06	9.6E-11	**1.0E-05**
Cadmium	4.40	5.3E-06	7.2E-08	1.8E-08	na	na	1.8E-03	na	na	3.2E-11	3.2E-11
Cobalt	10.1	1.2E-05	1.7E-06	4.1E-08	na	na	9.0E-03	na	na	3.7E-10	3.7E-10
Nickel	26.6	3.2E-05	4.4E-06	1.1E-07	na	na	2.6E-04	na	na	2.8E-11	2.8E-11
										ILCR	**1E-05**

Notes:

[a] Maximum detected concentration measured in riparian soil samples collected from background sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL — percent upper confidence limit
ILCR — incremental lifetime cancer risk
mg/kg — milligrams per kilogram
mg/kg-d — milligrams per kilogram per day
na — not available
URF — unit risk factor
ug/m^3 — microgram per cubic meter

Table C-9
Tier I Background Noncancer Hazard Calculation for a Current/Future Native American - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Dust Inhalation Dose (mg/m^3)	Reference Dose (mg/kg-d) [b]		RfC (mg/m^3) [b]	Pathway-Specific Hazard			Chemical-Specific HQ
					Oral	Dermal	Inhalation	Soil Ingestion	Dermal	Dust Inhalation	
Antimony	5.50	1.5E-05	2.1E-06	5.3E-11	4.0E-04	6.0E-05	na	3.9E-02	3.5E-02	na	0.074
Arsenic	5.44	9.2E-06	6.7E-06	5.2E-11	3.0E-04	3.0E-04	1.5E-05	3.1E-02	2.2E-02	3.5E-06	0.053
Cadmium	4.40	1.2E-05	1.7E-07	4.2E-11	1.0E-03	2.5E-05	1.0E-05	1.2E-02	6.8E-03	4.2E-06	0.019
Cobalt	10.1	2.8E-05	3.9E-06	9.6E-11	3.0E-04	3.0E-04	6.0E-06	9.5E-02	1.3E-02	1.6E-05	0.11
Manganese	1,080	3.0E-03	4.1E-04	1.0E-08	1.4E-01	5.6E-03	5.0E-05	2.2E-02	7.4E-02	2.1E-04	0.096
Nickel	26.6	7.5E-05	1.0E-05	2.5E-10	2.0E-02	8.0E-04	9.0E-05	3.7E-03	1.3E-02	2.8E-06	0.017
Selenium	1.80	5.1E-06	6.9E-07	1.7E-11	5.0E-03	1.5E-03	2.0E-02	1.0E-03	4.6E-04	8.6E-10	0.0015
Thallium	0.428	1.2E-06	1.6E-07	4.1E-12	1.0E-05	1.0E-05	na	1.2E-01	1.6E-02	na	0.14
Vanadium	57.3	1.6E-04	2.2E-05	5.5E-10	5.0E-03	1.3E-04	1.0E-04	3.2E-02	1.7E-01	5.5E-06	0.20
										HI	0.7

Notes:

[a] Maximum detected concentration measured in riparian soil samples collected from background sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL	percent upper confidence limit		milligrams per kilogram per day
HI	hazard index	mg/m^3	milligram per cubic meter
HQ	hazard quotient	na	not available
mg/kg	milligrams per kilogram	RfC	reference concentration
mg/kd-d	milligrams per kilogram per day		

Table C-10

Tier I Background Cancer Risk Calculation for a Current/Future Recreational Fisher, and Current/Future Native American and Hypothetical Future Resident who Fish - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Dust Inhalation Dose (ug/m^3)	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b] Oral	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b] Dermal	URF (ug/m^3)$^{-1}$ [b] Inhalation	Pathway-Specific Cancer Risk Soil Ingestion	Pathway-Specific Cancer Risk Dermal	Pathway-Specific Cancer Risk Dust Inhalation	Chemical-Specific Risk
Arsenic	5.44	3.2E-07	2.3E-07	3.6E-09	1.5E+00	1.5E+00	4.3E-03	4.8E-07	3.5E-07	1.6E-11	8.3E-07
Cadmium	4.40	4.3E-07	5.9E-09	2.9E-09	na	na	1.8E-03	na	na	5.3E-12	5.3E-12
Cobalt	10.1	9.9E-07	1.4E-07	6.7E-09	na	na	9.0E-03	na	na	6.1E-11	6.1E-11
Nickel	26.6	2.6E-06	3.6E-07	1.8E-08	na	na	2.6E-04	na	na	4.6E-12	4.6E-12
										ILCR	8E-07

Notes:

[a] Maximum detected concentration measured in riparian soil samples collected from background sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL	percent upper confidence limit	na	not available
ILCR	incremental lifetime cancer risk	URF	unit risk factor
mg/kg	milligrams per kilogram	ug/m^3	microgram per cubic meter
mg/kg-d	milligrams per kilogram per day		

Table C-11
Tier I Background Noncancer Hazard Calculation for a Current/Future Recreational Fisher, and Current/Future Native American and Hypothetical Future Resident who Fish - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Dust Inhalation Dose (mg/m^3)	Reference Dose (mg/kg-d) [b] Oral	Reference Dose (mg/kg-d) [b] Dermal	RfC (mg/m^3) [b] Inhalation	Pathway-Specific Hazard Soil Ingestion	Pathway-Specific Hazard Dermal	Pathway-Specific Hazard Dust Inhalation	Chemical-Specific HQ
Antimony	5.50	1.3E-06	1.7E-07	5.3E-11	4.0E-04	6.0E-05	na	3.2E-03	2.9E-03	na	0.0060
Arsenic	5.44	7.5E-07	5.4E-07	5.2E-11	3.0E-04	3.0E-04	1.5E-05	2.5E-03	1.8E-03	3.5E-06	0.0043
Cadmium	4.40	1.0E-06	1.4E-08	4.2E-11	1.0E-03	2.5E-05	1.0E-05	1.0E-03	5.5E-04	4.2E-06	0.0016
Cobalt	10.1	2.3E-06	3.2E-07	9.6E-11	3.0E-04	3.0E-04	6.0E-06	7.7E-03	1.1E-03	1.6E-05	0.0088
Manganese	1,080	2.5E-04	3.4E-05	1.0E-08	1.4E-01	5.6E-03	5.0E-05	1.8E-03	6.0E-03	2.1E-04	0.0080
Nickel	26.6	6.1E-06	8.3E-07	2.5E-10	2.0E-02	8.0E-04	9.0E-05	3.1E-04	1.0E-03	2.8E-06	0.0013
Selenium	1.80	4.1E-07	5.6E-08	1.7E-11	5.0E-03	1.5E-03	2.0E-02	8.3E-05	3.8E-05	8.6E-10	0.00012
Thallium	0.428	9.8E-08	1.3E-08	4.1E-12	1.0E-05	1.0E-05	na	9.8E-03	1.3E-03	na	0.011
Vanadium	57.3	1.3E-05	1.8E-06	5.5E-10	5.0E-03	1.3E-04	1.0E-04	2.6E-03	1.4E-02	5.5E-06	0.016
										HI	0.06

Notes:
[a] Maximum detected concentration measured in riparian soil samples collected from background sampling locations.
[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL	percent upper confidence limit
HI	hazard index
HQ	hazard quotient
mg/kg	milligrams per kilogram
mg/kd-d	milligrams per kilogram per day
	milligrams per kilogram per day
mg/m^3	milligram per cubic meter
na	not available
RfC	reference concentration

Table C-12
Summary of Tier I Background Human Health Risk Estimates - Riparian Soil

Analyte	Concentration[a] (mg/kg)			Current/Future Native American		Recreational Fisher / Native American or Resident who Fishes	
	Maximum	95% UCL	EPC[b]	ILCR	HQ	ILCR	HQ
Antimony	5.50	NA	5.50	NA	0.074	NA	0.0060
Arsenic	5.44	NA	5.44	**1.0E-05**	0.053	8.3E-07	0.0043
Cadmium	4.40	NA	4.40	3.2E-11	0.019	5.3E-12	0.0016
Cobalt	10.1	NA	10.1	3.7E-10	0.11	6.1E-11	0.0088
Manganese	1,080	NA	1,080	NA	0.096	NA	0.0080
Nickel	26.6	NA	26.6	2.8E-11	0.017	4.6E-12	0.0013
Selenium	1.80	NA	1.80	NA	0.0015	NA	0.00012
Thallium	0.428	NA	0.428	NA	0.14	NA	0.011
Vanadium	57.3	NA	57.3	NA	0.20	NA	0.016
Cumulative ILCR/HQ:				**1E-05**	0.7	8E-07	0.06
IDEQ Point of Departure:				10^{-5}	1		
USEPA Risk Range:				10^{-6} - 10^{-4}	1		

Notes:

[a] Maximum detected concentration measured in riparian soil samples collected from background sampling locations.

[b] The exposure point concentration (EPC) is the maximum detected concentration.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
NA - not applicable
USEPA - U. S. Environmental Protection Agency

Table C-13
Tier I Background Cancer Risk Calculation for a Current/Future Native American - Surface Water

Analyte	Surface Water Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Dermal	Pathway-Specific Cancer Risk Ingestion	Pathway-Specific Cancer Risk Dermal	Chemical-Specific Risk
Arsenic	0.00110	9.9E-08	3.7E-08	1.5E+00	1.5E+00	1.5E-07	5.5E-08	2.0E-07
							ILCR	2E-07

Notes:

[a] Maximum detected concentration measured in surface water samples collected from background sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor

% UCL	percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk		
mg/L	milligrams per liter		

Table C-14
Tier I Background Noncancer Hazard Calculation for a Current/Future Native American - Surface Water

Analyte	Surface Water Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Reference Dose (mg/kg-d) [b] Dermal	Pathway-Specific Hazard Ingestion	Pathway-Specific Hazard Dermal	Chemical-Specific HQ
Arsenic	0.00110	2.3E-07	8.6E-08	3.0E-04	3.0E-04	7.7E-04	2.9E-04	0.0011
Cadmium	0.000100	2.1E-08	7.8E-09	5.0E-04	2.5E-05	4.2E-05	3.1E-04	0.00035
Chromium	0.00393	8.3E-07	3.1E-07	1.5E+00	2.0E-02	5.5E-07	1.6E-05	0.000016
Cobalt	0.0100	2.1E-06	3.1E-07	3.0E-04	3.0E-04	7.0E-03	1.0E-03	0.0081
Manganese	0.0484	1.0E-05	3.8E-06	1.4E-01	5.6E-03	7.3E-05	6.7E-04	0.00075
Nickel	0.00221	4.7E-07	3.5E-08	2.0E-02	8.0E-04	2.3E-05	4.3E-05	0.000066
Selenium	0.00100	2.1E-07	7.8E-08	5.0E-03	1.5E-03	4.2E-05	5.2E-05	0.000094
Thallium	0.000150	3.2E-08	1.2E-08	1.0E-05	1.0E-05	3.2E-03	1.2E-03	0.0043
Vanadium	0.00620	1.3E-06	4.8E-07	5.0E-03	1.3E-04	2.6E-04	3.7E-03	0.0040
							HI	0.02

Notes:

[a] Maximum detected concentration measured in surface water samples collected from background sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose

% UCL	percent upper confidence limit	mg/kg	milligrams per kilogram
HI	hazard index	mg/kd-d	milligrams per kilogram per day
HQ	hazard quotient		

Table C-15

Tier I Background Cancer Risk Calculation for a Current/Future Recreational Fisher and Hypothetical Future Resident - Surface Water

Analyte	Surface Water Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Dermal	Pathway-Specific Cancer Risk Ingestion	Pathway-Specific Cancer Risk Dermal	Chemical-Specific Risk
Arsenic	0.00110	1.5E-08	5.6E-09	1.5E+00	1.5E+00	2.3E-08	8.4E-09	3.1E-08
							ILCR	3E-08

Notes:

[a] Maximum detected concentration measured in surface water samples collected from background sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor

% UCL	percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk		
mg/L	milligrams per liter		

Table C-16

Tier I Background Noncancer Hazard Calculation for a Current/Future Recreational Fisher and Hypothetical Future Resident - Surface Water

Analyte	Surface Water Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Reference Dose (mg/kg-d) [b] Dermal	Pathway-Specific Hazard Ingestion	Pathway-Specific Hazard Dermal	Chemical-Specific HQ
Arsenic	0.00110	3.5E-08	1.3E-08	3.0E-04	3.0E-04	1.2E-04	4.4E-05	0.00016
Cadmium	0.000100	3.2E-09	1.2E-09	5.0E-04	2.5E-05	6.4E-06	4.8E-05	0.000054
Chromium	0.00393	1.3E-07	4.7E-08	1.5E+00	2.0E-02	8.4E-08	2.4E-06	0.0000025
Cobalt	0.0100	3.2E-07	4.8E-08	3.0E-04	3.0E-04	1.1E-03	1.6E-04	0.0012
Manganese	0.0484	1.6E-06	5.8E-07	1.4E-01	5.6E-03	1.1E-05	1.0E-04	0.00011
Nickel	0.00221	7.1E-08	5.3E-09	2.0E-02	8.0E-04	3.6E-06	6.6E-06	0.000010
Selenium	0.00100	3.2E-08	1.2E-08	5.0E-03	1.5E-03	6.4E-06	8.0E-06	0.000014
Thallium	0.000150	4.8E-09	1.8E-09	1.0E-05	1.0E-05	4.8E-04	1.8E-04	0.00066
Vanadium	0.00620	2.0E-07	7.4E-08	5.0E-03	1.3E-04	4.0E-05	5.7E-04	0.00061
							HI	0.003

Notes:

[a] Maximum detected concentration measured in surface water samples collected from background sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose

% UCL	percent upper confidence limit	mg/kg	milligrams per kilogram
HI	hazard index	mg/kd-d	milligrams per kilogram per day
HQ	hazard quotient		

Table C-17
Summary of Tier I Background Human Health Risk Estimates - Surface Water

Analyte	Concentration[a] (mg/L)			Current/Future Native American		Current/Future Recreational Fisher / Hypothetical Future Resident who Fishes	
	Maximum	**95% UCL**	**EPC[b]**	**ILCR**	**HQ**	**ILCR**	**HQ**
Arsenic	0.00110	NA	0.00110	2E-07	0.0011	3E-08	0.00016
Cadmium	0.000100	NA	0.000100	NA	0.00035	NA	0.000054
Chromium	0.00393	NA	0.00393	NA	0.000016	NA	0.0000025
Cobalt	0.0100	NA	0.0100	NA	0.0081	NA	0.0012
Manganese	0.0484	NA	0.0484	NA	0.00075	NA	0.00011
Nickel	0.00221	NA	0.00221	NA	0.000066	NA	0.000010
Selenium	0.00100	NA	0.00100	NA	0.000094	NA	0.000014
Thallium	0.000150	NA	0.000150	NA	0.0043	NA	0.00066
Vanadium	0.00620	NA	0.00620	NA	0.0040	NA	0.00061
Cumulative ILCR/HQ				2E-07	0.02	3E-08	0.003
IDEQ Point of Departure:				10^{-5}	1		
USEPA Risk Range:				10^{-6} - 10^{-4}	1		

Notes:

[a] Maximum detected concentration measured in surface water samples collected from background sampling locations.

[b] The exposure point concentration (EPC) is the maximum detected concentration.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/L - milligrams per liter
NA - not applicable
USEPA - U. S. Environmental Protection Agency

Table C-18
Tier I Background Cancer Risk Calculation for a Hypothetical Future Resident - Groundwater

Analyte	Groundwater Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b]		Pathway-Specific Cancer Risk		Chemical-Specific Risk
				Oral	Dermal	Ingestion	Dermal	
Arsenic	0.000989	1.7E-05	1.0E-07	1.5E+00	1.5E+00	2.6E-05	1.5E-07	**2.6E-05**
							ILCR	**3E-05**

Notes:

[a] Maximum detected concentration measured in groundwater samples collected from background sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor

% UCL	percent upper confidence limit
ILCR	incremental lifetime cancer risk
mg/L	milligrams per liter
mg/kg-d	milligrams per kilogram per day
NA	not applicable

Table C-19
Tier I Background Noncancer Hazard Calculation for a Hypothetical Future Resident - Groundwater

Analyte	Groundwater Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Reference Dose (mg/kg-d) [b] Dermal	Pathway-Specific Hazard Ingestion	Pathway-Specific Hazard Dermal	Chemical-Specific HQ
Arsenic	0.000989	4.1E-05	2.3E-07	3.0E-04	3.0E-04	1.4E-01	7.8E-04	0.14
Chromium	0.00524	2.2E-04	1.2E-06	1.5E+00	2.0E-02	1.4E-04	6.4E-05	0.00021
Cobalt	0.000436	1.8E-05	4.1E-08	3.0E-04	3.0E-04	6.0E-02	1.4E-04	0.060
Manganese	0.456	1.9E-02	1.1E-04	1.4E-01	5.6E-03	1.3E-01	1.9E-02	0.15
Molybdenum	0.0239	9.8E-04	5.7E-06	5.0E-03	5.0E-03	2.0E-01	1.1E-03	0.20
Selenium	0.00267	1.1E-04	6.3E-07	5.0E-03	1.5E-03	2.2E-02	4.2E-04	0.022
Thallium	0.000200	8.2E-06	4.7E-08	1.0E-05	1.0E-05	8.2E-01	4.7E-03	0.83
							HI	1

Notes:

[a] Maximum detected concentration measured in groundwater samples collected from background sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose

% UCL	percent upper confidence limit	mg/kg	milligrams per kilogram
HI	hazard index	mg/kd-d	milligrams per kilogram per day
HQ	hazard quotient	NA	not applicable

Table C-20
Tier I Background Cancer Risk Calculation for a Current/Future Seasonal Rancher - Groundwater

Analyte	Groundwater Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Dermal	Pathway-Specific Cancer Risk Ingestion	Pathway-Specific Cancer Risk Dermal	Chemical-Specific Risk
Arsenic	0.000989	3.2E-06	2.2E-08	1.5E+00	1.5E+00	4.8E-06	3.3E-08	**4.8E-06**
							ILCR	**5E-06**

Notes:

[a] Maximum detected concentration measured in groundwater samples collected from background sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor

% UCL	percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	NA	not applicable
mg/L	milligrams per liter		

Table C-21
Tier I Background Noncancer Hazard Calculation for a Current/Future Seasonal Rancher - Groundwater

Analyte	Groundwater Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b]		Pathway-Specific Hazard		Chemical-Specific HQ
				Oral	Dermal	Ingestion	Dermal	
Arsenic	0.000989	3.9E-07	6.4E-08	3.0E-04	3.0E-04	1.3E-03	2.1E-04	0.0015
Chromium	0.00524	2.1E-06	3.4E-07	1.5E+00	2.0E-02	1.4E-06	1.7E-05	0.000019
Cobalt	0.000436	1.7E-07	1.1E-08	3.0E-04	3.0E-04	5.7E-04	3.7E-05	0.00061
Manganese	0.456	1.8E-04	2.9E-05	1.4E-01	5.6E-03	1.3E-03	5.2E-03	0.0065
Molybdenum	0.0239	9.4E-06	1.5E-06	5.0E-03	5.0E-03	1.9E-03	3.1E-04	0.0022
Selenium	0.00267	1.0E-06	1.7E-07	5.0E-03	1.5E-03	2.1E-04	1.1E-04	0.00032
Thallium	0.000200	7.8E-08	1.3E-08	1.0E-05	1.0E-05	7.8E-03	1.3E-03	0.0091
							HI	0.02

Notes:

[a] Maximum detected concentration measured in groundwater samples collected from background sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose

% UCL	percent upper confidence limit	mg/kg	milligrams per kilogram
HI	hazard index	mg/kd-d	milligrams per kilogram per day
HQ	hazard quotient	NA	not applicable

Table C-22
Summary of Tier I Background Human Health Risk Estimates - Groundwater

	Concentration[a] (mg/L)			Hypothetical Future Resident		Current/Future Seasonal Rancher	
Analyte	**Maximum**	**95% UCL**	**EPC[b]**	**ILCR**	**HQ**	**ILCR**	**HQ**
Arsenic	0.000989	NA	0.000989	**2.6E-05**	0.14	**4.8E-06**	0.0015
Chromium	0.00524	NA	0.00524	NA	0.00021	NA	0.000019
Cobalt	0.000436	NA	0.000436	NA	0.060	NA	0.00061
Manganese	0.456	NA	0.456	NA	0.15	NA	0.0065
Molybdenum	0.0239	NA	0.0239	NA	0.20	NA	0.0022
Selenium	0.00267	NA	0.00267	NA	0.022	NA	0.00032
Thallium	0.000200	NA	0.000200	NA	0.83	NA	0.0091
Cumulative ILCR/HQ				**3E-05**	1	**5E-06**	0.02
IDEQ Point of Departure:				10^{-5}	1		
USEPA Risk Range:				10^{-6} - 10^{-4}	1		

Notes:

[a] Maximum detected concentration measured in groundwater samples collected from background sampling locations.

[b] The exposure point concentration (EPC) is the maximum detected concentration.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/L - milligrams per liter
NA - not applicable
USEPA - U. S. Environmental Protection Agency

Table C-23

Tier I Background Cancer Risk Calculation for a Current/Future Native American - Culturally Significant Plants - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Modeled Culturally Significant Plant Concentration from Soil (mg/kg)	Measured Culturally Significant Plants Concentration (mg/kg)	Modeled Plant Ingestion Dose (mg/kg-d)	Measured Plant Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Pathway-Specific Cancer Risk: Modeled Plant Ingestion	Pathway-Specific Cancer Risk: Measured Plant Ingestion	Chemical-Specific Risk [c]
Arsenic	19.0	0.447	na	1.0E-03	na	1.5E+00	1.5E-03	na	**1.5E-03**
								ILCR	**1E-03**

Notes:

[a] The exposure point concentration (EPC) is equal to the maximum detected concentration.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

[c] Where available, measured plant concentrations were used preferentially over modeled plant concentrations to calculate risk.

% UCL — percent upper confidence limit
ILCR — incremental lifetime cancer risk
mg/kg — milligrams per kilogram
mg/kg-d — milligrams per kilogram per day
na — not available

Table C-24
Tier I Background Noncancer Hazard Calculation for a Current/Future Native American - Culturally Significant Plants - Upland Soi

Analyte	Upland Soil Concentration[a] (mg/kg)	Modeled Culturally Significant Plant Concentration from Soil (mg/kg)	Measured Culturally Significant Plants Concentration (mg/kg)	Modeled Plant Ingestion Dose (mg/kg-d)	Measured Plant Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Pathway-Specific Hazard: Modeled Plant Ingestion	Pathway-Specific Hazard: Measured Plant Ingestion	Chemical-Specific HQ [c]
Antimony	3.60	0.229	2.93	1.2E-03	1.5E-02	4.0E-04	3.0	38	**38**
Arsenic	19.0	0.447	na	2.3E-03	na	3.0E-04	7.8	na	**7.8**
Cadmium	44.0	6.09	0.663	3.2E-02	3.5E-03	1.0E-03	32	3.5	**3.5**
Cobalt	13.3	0.246	na	1.3E-03	na	3.0E-04	4.3	na	**4.3**
Manganese	3,990	303	na	1.6E+00	na	1.4E-01	11	na	**11**
Nickel	230	6.56	na	3.4E-02	na	2.0E-02	1.7	na	**1.7**
Selenium	29.0	0.573	1.08	3.0E-03	5.6E-03	5.0E-03	0.60	1.1	**1.1**
Thallium	1.30	0.0189	0.00398	9.8E-05	2.1E-05	1.0E-05	9.8	2.1	**2.1**
Uranium	42.0	0.657	0.0551	3.4E-03	2.9E-04	2.0E-04	17	1.4	**1.4**
Vanadium	370	5.51	na	2.9E-02	na	5.0E-03	5.7	na	**5.7**
								HI	**77**

Notes:

[a] The exposure point concentration (EPC) is equal to the maximum detected concentration.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

[c] Where available, measured plant concentrations were used preferentially over modeled plant concentrations to calculate an HQ.

% UCL	percent upper confidence limit	mg/kd	milligrams per kilogram
HI	hazard index	mg/kd-d	milligrams per kilogram per day
HQ	hazard quotient	na	not available

Table C-25
Summary of Tier I Background Human Health Risk Estimates - Culturally Significant Plants - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)			Modeled Culturally Significant Plants Concentration (mg/kg)	Measured Culturally Significant Plants Concentration (mg/kg)	Current/Future Native American	
	Maximum	95% UCL	EPC[b]	EPC[c]	EPC[d]	ILCR	HQ
Antimony	3.60	NA	3.60	0.229	2.93	NA	**38**
Arsenic	19.0	NA	19.0	0.447	na	**1.5E-03**	**7.8**
Cadmium	44.0	NA	44.0	6.09	0.663	NA	**3.5**
Cobalt	13.3	NA	13.3	0.246	na	NA	**4.3**
Manganese	3,990	NA	3,990	303	na	NA	**11**
Nickel	230	NA	230	6.56	na	NA	**1.7**
Selenium	29.0	NA	29.0	0.573	1.08	NA	**1.1**
Thallium	1.30	NA	1.30	0.0189	0.00398	NA	**2.1**
Uranium	42.0	NA	42.0	0.657	0.0551	NA	**1.4**
Vanadium	370	NA	370	5.51	na	NA	**5.7**
					Cumulative ILCR/HQ:	**1E-03**	**77**
					IDEQ Point of Departure:	10^{-5}	1
					USEPA Risk Range:	10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration measured in upland soil samples collected from background sampling locations.

[b] The exposure point concentration (EPC) is equal to the maximum detected concentration.

[c] The culturally significant plants EPC was modeled from the upland soil EPC using soil-to-plant uptake factors.

[d] The maximum detected concentration measured in culturally significant plants samples in wet weight. The dry weight culturally significant plants data were converted to wet weight using an average moisture content of 66 percent.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
NA - not applicable
na - not available
USEPA - U. S. Environmental Protection Agency

Table C-26
Tier I Background Cancer Risk Calculation for a Current/Future Native American - Culturally Significant Plants - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg)	Modeled Culturally Significant Plant Concentration from Soil (mg/kg)	Measured Riparian Plant Concentration (mg/kg)	Modeled Plant Ingestion Dose (mg/kg-d)	Measured Plant Ingestion Dose (mg/kg-d)	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b] Oral	Pathway-Specific Cancer Risk: Modeled Plant Ingestion	Pathway-Specific Cancer Risk: Measured Plant Ingestion	Chemical-Specific Risk [c]
Arsenic	5.44	0.128	na	2.9E-04	na	1.5E+00	4.3E-04	na	**4.3E-04**
								ILCR	**4E-04**

Notes:

[a] The exposure point concentration (EPC) is equal to the maximum detected concentration.
[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.
[c] Where available, measured plant concentrations were used preferentially over modeled plant concentrations to calculate risk.

% UCL	percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	na	not available
mg/kg	milligrams per kilogram		

Table C-27
Tier I Background Noncancer Hazard Calculation for a Current/Future Native American - Culturally Significant Plants - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg)	Modeled Culturally Significant Plant Concentration from Soil (mg/kg)	Measured Riparian Plant Concentration (mg/kg)	Modeled Plant Ingestion Dose (mg/kg-d)	Measured Plant Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Pathway-Specific Hazard: Modeled Plant Ingestion	Pathway-Specific Hazard: Measured Plant Ingestion	Chemical-Specific HQ [c]
Antimony	5.50	0.349	na	1.8E-03	na	4.0E-04	4.5E+00	na	**4.5**
Arsenic	5.44	0.128	na	6.7E-04	na	3.0E-04	2.2E+00	na	**2.2**
Cadmium	4.40	0.609	0.306	3.2E-03	1.6E-03	1.0E-03	3.2E+00	1.6E+00	**1.6**
Cobalt	10.1	0.187	na	9.7E-04	na	3.0E-04	3.2E+00	na	**3.2**
Manganese	1,080	82.1	na	4.3E-01	na	1.4E-01	3.1E+00	na	**3.1**
Nickel	26.6	0.759	na	3.9E-03	na	2.0E-02	2.0E-01	na	0.20
Selenium	1.80	0.0356	0.272	1.9E-04	1.4E-03	5.0E-03	3.7E-02	2.8E-01	0.28
Thallium	0.428	0.00621	na	3.2E-05	na	1.0E-05	3.2E+00	na	**3.2**
Vanadium	57.3	0.854	na	4.4E-03	na	5.0E-03	8.9E-01	na	0.89
								HI	**19**

Notes:

[a] The exposure point concentration (EPC) is equal to the maximum detected concentration.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

[c] Where available, measured plant concentrations were used preferentially over modeled plant concentrations to calculate an HQ.

HI	hazard index	mg/kg-d	milligrams per kilogram per day
HQ	hazard quotient	na	not available
mg/kg	milligrams per kilogram		

Table C-28
Summary of Tier I Background Human Health Risk Estimates - Culturally Significant Plants - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg)			Modeled Culturally Significant Plants Concentration (mg/kg)	Measured Riparian Plants Concentration (mg/kg)	Current/Future Native American	
	Maximum	95% UCL	EPC[b]	EPC[c]	EPC[d]	ILCR	HQ
Antimony	5.50	NA	5.50	0.349	na	NA	**4.5**
Arsenic	5.44	NA	5.44	0.128	na	**4.3E-04**	**2.2**
Cadmium	4.40	NA	4.40	0.609	0.306	NA	**1.6**
Cobalt	10.1	NA	10.1	0.187	na	NA	**3.2**
Manganese	1,080	NA	1,080	82.1	na	NA	**3.1**
Nickel	26.6	NA	26.6	0.759	na	NA	0.20
Selenium	1.80	NA	1.80	0.0356	0.272	NA	0.28
Thallium	0.428	NA	0.428	0.00621	na	NA	**3.2**
Vanadium	57.3	NA	57.3	0.854	na	NA	0.89
					Cumulative ILCR/HQ:	**4E-04**	**19**
					IDEQ Point of Departure:	10^{-5}	1
					USEPA Risk Range:	10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration measured in riparian soil samples collected from background sampling locations.

[b] The exposure point concentration (EPC) is equal to the maximum detected concentration.

[c] The culturally significant plants EPC was modeled from the riparian soil EPC using soil-to-plant uptake factors.

[d] The maximum detected concentration measured in culturally significant plants samples in wet weight. The dry weight culturally significant plants data were converted to wet weight using an average moisture content of 66 percent.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk

mg/kg - milligrams per kilogarm
NA - not applicable
na - not available
USEPA - U. S. Environmental Protection Agency

Table C-29
Tier I Background Cancer Risk Calculation for a Hypothetical Future Resident - Fruits and Vegetables - Upland Soil and Groundwater

Analyte	Upland Soil Concentration[a] (mg/kg)	Groundwater Concentration[a] (mg/L)	Modeled Fruits and Vegetables Concentration from Soil (mg/kg)	Modeled Fruits and Vegetables Concentration from Groundwater (mg/kg)	Measured Non-Culturally Significant Plants Concentration (mg/kg)	Total Fruits and Vegetables Concentration [b] (mg/kg)	Plant Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [c] Oral	Chemical-Specific Risk
Arsenic	19.0	0.000989	0.447	0.00443	na	0.451	1.0E-03	1.5E+00	**1.5E-03**
								ILCR	**2E-03**

Notes:

[a] Maximum detected concentration measured in fruits and vegetables samples collected from background sampling locations.

[b] For an analyte that is only a chemical of potential concern (COPC) in soil, measured non-culturally significant plant concentration, when available, was used to represent the fruits and vegetables concentration. If an analyte is a COPCs in groundwater, the total fruits and vegetables concentration is equal to the modeled concentration from groundwater plus either the measured non-culturally significant plant concentration when available, or the modeled concentration from soil.

[c] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/L	milligrams per liter
ILCR	incremental lifetime cancer risk	na	not available
mg/kg	milligrams per kilogram		
mg/kd-d	milligrams per kilogram per day		

Table C-30
Tier I Background Noncancer Hazard Calculation for a Hypothetical Future Resident - Fruits and Vegetables - Upland Soil and Groundwater

Analyte	Upland Soil Concentration[a] (mg/kg)	Groundwater Concentration[a] (mg/L)	Modeled Fruits and Vegetables Concentration from Soil (mg/kg)	Modeled Fruits and Vegetables Concentration from Groundwater (mg/kg)	Measured Non-Culturally Significant Plants Concentration (mg/kg)	Total Fruits and Vegetables Concentration [b] (mg/kg)	Plant Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [c] Oral	Chemical-Specific HQ
Antimony	3.60	NA	0.229	NA	1.84	1.84	9.6E-03	4.0E-04	**24**
Arsenic	19.0	0.000989	0.447	0.00443	na	0.451	2.3E-03	3.0E-04	**7.8**
Cadmium	44.0	NA	6.09	NA	0.537	0.537	2.8E-03	1.0E-03	**2.8**
Chromium	NA	0.00524	NA	0.0220	na	0.0220	1.1E-04	1.5E+00	0.000076
Cobalt	13.3	0.000436	0.2463	0.00188	na	0.248	1.3E-03	3.0E-04	**4.3**
Manganese	3,990	0.456	303	2.90	na	306	1.6E+00	1.4E-01	**11**
Molybdenum	NA	0.0239	NA	0.152	3.03	3.18	1.7E-02	5.0E-03	**3.3**
Nickel	230	NA	6.56	NA	na	6.56	3.4E-02	2.0E-02	**1.7**
Selenium	29.0	0.00267	0.573	0.0116	2.48	2.49	1.3E-02	5.0E-03	**2.6**
Thallium	1.30	0.000200	0.01888	0.000832	0.00874	0.00957	5.0E-05	1.0E-05	**5.0**
Uranium	42.0	NA	0.6573	NA	0.0367	0.0367	1.9E-04	2.0E-04	0.96
Vanadium	370	NA	5.513	NA	na	5.51	2.9E-02	5.0E-03	**5.7**
								HI	**70**

Notes:

[a] Maximum detected concentration measured in fruits and vegetables samples collected from background sampling locations.

[b] For an analyte that is only a constituent of potential concern (COPC) in soil, measured non-culturally significant plant concentration, when available, was used to represent the fruits and vegetables concentration. If an analyte is a COPC in groundwater, the total fruits and vegetables concentration is equal to the modeled concentration from groundwater plus either the measured non-culturally significant plant concentration when available, or the modeled concentration from soil.

[c] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kg	milligrams per kilogram	na	not available
HI	hazard index	mg/kd-d	milligrams per kilogram per day	NA	not applicable
HQ	hazard quotient	mg/L	milligrams per liter		

Table C-31
Summary of Tier I Background Human Health Risk Estimates - Fruits and Vegetables - Upland Soil and Groundwater

	Upland Soil Concentration[a] (mg/kg)			Groundwater Concentration[a] (mg/L)			Modeled Total Fruits and Vegetables Concentration (mg/kg)	Measured Non-Culturally Significant Plants Concentration (mg/kg)	Hypothetical Future Resident	
Analyte	**Maximum**	**95% UCL**	**EPC[b]**	**Maximum**	**95% UCL**	**EPC[c]**	**EPC[d]**	**EPC[e]**	**ILCR**	**HQ**
Antimony	3.60	NA	3.60	NA	NA	NA	1.84	1.84	NA	**24**
Arsenic	19.0	NA	19.0	0.000989	NA	0.000989	0.451	na	**1.5E-03**	**7.8**
Cadmium	44.0	NA	44.0	NA	NA	NA	0.537	0.537	NA	**2.8**
Chromium	NA	NA	NA	0.00524	NA	0.00524	0.0220	na	NA	0.000076
Cobalt	13.3	NA	13.3	0.000436	NA	0.000436	0.248	na	NA	**4.3**
Manganese	3,990	NA	3,990	0.456	NA	0.456	306	na	NA	**11**
Molybdenum	NA	NA	NA	0.0239	NA	0.0239	3.18	3.03	NA	**3.3**
Nickel	230	NA	230	NA	NA	NA	6.56	na	NA	**1.7**
Selenium	29.0	NA	29.0	0.00267	NA	0.00267	2.49	2.48	NA	**2.6**
Thallium	1.30	NA	1.30	0.000200	NA	0.000200	0.00957	0.00874	NA	**5.0**
Uranium	42.0	NA	42.0	NA	NA	NA	0.0367	0.0367	NA	0.96
Vanadium	370	NA	370	NA	NA	NA	5.51	na	NA	**5.7**
Cumulative ILCR/HQ:									**2E-03**	**70**
IDEQ Point of Departure:									10^{-5}	1
USEPA Risk Range:									10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration measured in upland soil and groundwater samples collected from background sampling locations.

[b] The soil EPC used to model fruits and vegetables concentration is the maximum detected concentration.

[c] The groundwater EPC used to model fruits and vegetables concentration is the maximum detected concentration.

[d] The fruits and vegetables EPC was modeled from the groundwater EPC and the measured plant EPC, where available, or the soil EPC, using plant uptake factors as described in Table C-29 and Table C-30.

[e] Maximum detected concentration measured in non-culturally significant plant samples in wet weight. The dry weight non-culturally significant data were converted to wet weight using an average moisture content of 66 percent.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk

mg/kg - milligrams per kilogarm
mg/L - milligrams per liter
NA - not applicable
na - not available
USEPA - U. S. Environmental Protection Agency

Table C-32
Tier I Background Cancer Risk Calculation for a Current/Future Native American - Elk - Upland Soil and Surface Water

Analyte	Upland Soil Concentration[a] (mg/kg)	Surface Water Concentration[a] (mg/L)	Modeled Elk Concentration from Soil (mg/kg)	Modeled Elk Concentration from Surface Water (mg/kg)	Total Elk Concentration (mg/kg)	Modeled Elk Ingestion Dose (mg/kg-d)	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b] Oral	Chemical-Specific Risk
Arsenic	19.0	0.00110	0.000324	0.0000354	0.000359	1.1E-07	1.5E+00	1.7E-07
							ILCR	2E-07

Notes:

[a] Maximum detected concentration measured in upland soil and surface water samples collected from background sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit
ILCR	incremental lifetime cancer risk
mg/kg	milligrams per kilogram
mg/kg-d	milligrams per kilogram per day
mg/L	milligrams per liter

Table C-33
Tier I Background Noncancer Hazard Calculation for a Current/Future Native American - Elk - Upland Soil and Surface Water

Analyte	Upland Soil Concentration[a] (mg/kg)	Surface Water Concentration[a] (mg/L)	Modeled Elk Concentration from Soil (mg/kg)	Modeled Elk Concentration from Surface Water (mg/kg)	Total Elk Concentration (mg/kg)	Modeled Elk Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Chemical-Specific HQ
Antimony	3.60	NA	0.000112	NA	0.000112	8.4E-08	4.0E-04	0.00021
Arsenic	19.0	0.00110	0.000324	0.0000354	0.000359	2.7E-07	3.0E-04	0.00089
Cadmium	44.0	0.000100	0.00179	0.000000885	0.00179	1.3E-06	1.0E-03	0.0013
Chromium	NA	0.00393	NA	0.000348	0.000348	2.6E-07	1.5E+00	0.00000017
Cobalt	13.3	0.0100	0.00151	0.00322	0.00473	3.5E-06	3.0E-04	0.012
Manganese	3,990	0.0484	0.0612	0.000311	0.0615	4.6E-05	1.4E-01	0.00033
Nickel	230	0.00221	0.0157	0.000213	0.0159	1.2E-05	2.0E-02	0.00059
Selenium	29.0	0.00100	0.00278	0.000241	0.00302	2.2E-06	5.0E-03	0.00045
Thallium	1.30	0.000150	0.000177	0.0000965	0.000274	2.0E-07	1.0E-05	0.020
Uranium	42.0	NA	0.0000340	NA	0.0000340	2.5E-08	2.0E-04	0.00013
Vanadium	370	0.00620	0.00335	0.000249	0.00360	2.7E-06	5.0E-03	0.00054
							HI	0.04

Notes:

[a] Maximum detected concentration measured in upland soil and surface water samples collected from background sampling locations.

[b] Doses and noncancer hazards shown only for chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	mg/L	milligrams per liter
HQ	hazard quotient	NA	not applicable
mg/kg	milligrams per kilogram		

Table C-34
Summary of Tier I Background Human Health Risk Estimates - Elk - Upland Soil and Surface Water

Analyte	Upland Soil Concentration[a] (mg/kg)			Surface Water Concentration[a] (mg/L)			Modeled Elk Concentration (mg/kg)	Current/Future Native American	
	Maximum	95% UCL	EPC[b]	Maximum	95% UCL	EPC[b]	EPC[c]	ILCR	HQ
Antimony	3.60	NA	3.60	NA	NA	NA	0.000112	NA	0.00021
Arsenic	19.0	NA	19.0	0.00110	NA	0.00110	0.000359	1.7E-07	0.00089
Cadmium	44.0	NA	44.0	0.000100	NA	0.000100	0.00179	NA	0.0013
Chromium	NA	NA	NA	0.00393	NA	0.00393	0.000348	NA	0.00000017
Cobalt	13.3	NA	13.3	0.0100	NA	0.0100	0.00473	NA	0.012
Manganese	3,990	NA	3,990	0.0484	NA	0.0484	0.0615	NA	0.00033
Nickel	230	NA	230	0.00221	NA	0.00221	0.0159	NA	0.00059
Selenium	29.0	NA	29.0	0.00100	NA	0.00100	0.00302	NA	0.00045
Thallium	1.30	NA	1.30	0.000150	NA	0.000150	0.000274	NA	0.020
Uranium	42.0	NA	42.0	NA	NA	NA	0.0000340	NA	0.00013
Vanadium	370	NA	370	0.00620	NA	0.00620	0.0036	NA	0.00054
Cumulative ILCR/HQ:								2E-07	0.04
IDEQ Point of Departure:								10^{-5}	1
USEPA Risk Range:								10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration measured in upland soil and surface water samples collected from background sampling locations.

[b] The upland soil and surface water EPCs used to model elk concentrations are the maximum detected concentration in those media.

[c] The elk EPC was modeled from upland soil and surface water EPCs.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
mg/L - milligrams per liter
NA - not applicable
USEPA - U. S. Environmental Protection Agency

Table C-35
Tier I Background Cancer Risk Calculation for a Current/Future Seasonal Rancher - Cattle - Upland Soil and Surface Water

Analyte	Upland Soil Concentration[a] (mg/kg)	Surface Water Concentration (mg/L)	Modeled Cattle Concentration from Soil (mg/kg)	Modeled Cattle Concentration from Surface Water (mg/kg)	Total Cattle Concentration (mg/kg)	Modeled Cattle Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Chemical-Specific Risk
Arsenic	19.0	0.00110	0.0108	0.000117	0.0109	2.4E-05	1.5E+00	**3.6E-05**
							ILCR	**4E-05**

Notes:

[a] Maximum detected concentration measured in upland soil and surface water samples collected from background sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	mg/L	milligrams per liter
mg/kg	milligrams per kilogram		

Table C-36
Tier I Background Noncancer Hazard Calculation for a Current/Future Seasonal Rancher - Cattle - Upland Soil and Surface Water

Analyte	Upland Soil Concentration[a] (mg/kg)	Surface Water Concentration[a] (mg/L)	Modeled Cattle Concentration from Soil (mg/kg)	Modeled Cattle Concentration from Surface Water (mg/kg)	Total Cattle Concentration (mg/kg)	Modeled Cattle Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Chemical-Specific HQ
Antimony	3.60	NA	0.00325	NA	0.00325	2.1E-05	4.0E-04	0.053
Arsenic	19.0	0.00110	0.0108	0.000117	0.0109	7.1E-05	3.0E-04	0.24
Cadmium	44.0	0.000100	0.0499	0.00000292	0.0499	3.3E-04	1.0E-03	0.33
Chromium	NA	0.00393	NA	0.00115	0.00115	7.5E-06	1.5E+00	0.0000050
Cobalt	13.3	0.0100	0.0547	0.0106	0.0653	4.3E-04	3.0E-04	**1.4**
Manganese	3,990	0.0484	1.75	0.00103	1.75	1.1E-02	1.4E-01	0.081
Nickel	230	0.00221	0.497	0.000703	0.498	3.2E-03	2.0E-02	0.16
Selenium	29.0	0.00100	0.0979	0.000795	0.0987	6.4E-04	5.0E-03	0.13
Thallium	1.30	0.000150	0.00747	0.000318	0.00779	5.1E-05	1.0E-05	**5.1**
Uranium	42.0	NA	0.00135	NA	0.00135	8.8E-06	2.0E-04	0.044
Vanadium	370	0.00620	0.138	0.000822	0.139	9.1E-04	5.0E-03	0.18
							HI	**8**

Notes:
[a] Maximum detected concentration measured in upland soil and surface water samples collected from background sampling locations.
[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	mg/L	milligrams per liter
HQ	hazard quotient	NA	not applicable
mg/kg	milligrams per kilogram		

Table C-37

Summary of Tier I Background Human Health Risk Estimates - Cattle - Upland Soil and Surface Water

	Upland Soil Concentration[a] (mg/kg)			Surface Water Concentration[a] (mg/L)			Modeled Cattle Concentration (mg/kg)	Current/Future Seasonal Rancher	
Analyte	**Maximum**	**95% UCL**	**EPC[b]**	**Maximum**	**95% UCL**	**EPC[b]**	**EPC[c]**	**ILCR**	**HQ**
Antimony	3.60	NA	3.60	NA	NA	NA	0.00325	NA	0.053
Arsenic	19.0	NA	19.0	0.00110	NA	0.00110	0.0109	**3.6E-05**	0.24
Cadmium	44.0	NA	44.0	0.000100	NA	0.000100	0.0499	NA	0.33
Chromium	NA	NA	NA	0.00393	NA	0.00393	0.00115	NA	0.0000050
Cobalt	13.3	NA	13.3	0.0100	NA	0.0100	0.0653	NA	**1.4**
Manganese	3,990	NA	3,990	0.0484	NA	0.0484	1.75	NA	0.081
Nickel	230	NA	230	0.00221	NA	0.00221	0.498	NA	0.16
Selenium	29.0	NA	29.0	0.00100	NA	0.00100	0.0987	NA	0.13
Thallium	1.30	NA	1.30	0.000150	NA	0.000150	0.00779	NA	**5.1**
Uranium	42.0	NA	42.0	NA	NA	NA	0.00135	NA	0.044
Vanadium	370	NA	370	0.00620	NA	0.00620	0.139	NA	0.18
							Cumulative ILCR/HQ:	**4E-05**	**8**
							IDEQ Point of Departure:	10^{-5}	1
							USEPA Risk Range:	10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration measured in upland soil and surface water samples collected from background sampling locations.

[b] The upland soil and groundwater EPCs used to model cattle concentration are the maximum detected concentrations in those media.

[d] The cattle EPC was modeled from upland soil and surface water EPCs.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk

mg/kg - milligrams per kilogarm
mg/L - milligrams per liter
NA - not applicable
USEPA - U. S. Environmental Protection Agency

Table C-38
Tier I Background Cancer Risk Calculation for a Current/Future Seasonal Rancher - Cattle - Upland Soil and Groundwater

Analyte	Upland Soil Concentration[a] (mg/kg)	Groundwater Concentration (mg/L)	Modeled Cattle Concentration from Soil (mg/kg)	Modeled Cattle Concentration from Groundwater (mg/kg)	Total Cattle Concentration (mg/kg)	Modeled Cattle Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Chemical-Specific Risk
Arsenic	19.0	0.000989	0.0108	0.000105	0.0109	2.4E-05	1.5E+00	**3.6E-05**
							ILCR	**4E-05**

Notes:

[a] Maximum detected concentration measured in upland soil and groundwater samples collected from background sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	mg/L	milligrams per liter
mg/kg	milligrams per kilogram		

Table C-39
Tier I Background Noncancer Hazard Calculation for a Current/Future Seasonal Rancher - Cattle - Upland Soil and Groundwater

Analyte	Upland Soil Concentration[a] (mg/kg)	Groundwater Concentration[a] (mg/L)	Modeled Cattle Concentration from Soil (mg/kg)	Modeled Cattle Concentration from Groundwater (mg/kg)	Total Cattle Concentration (mg/kg)	Modeled Cattle Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Chemical-Specific HQ
Antimony	3.60	NA	0.00325	NA	0.00325	2.1E-05	4.0E-04	0.053
Arsenic	19.0	0.000989	0.0108	0.000105	0.0109	7.1E-05	3.0E-04	0.24
Cadmium	44.0	NA	0.0499	NA	0.0499	3.3E-04	1.0E-03	0.33
Chromium	NA	0.00524	NA	0.00153	0.00153	1.0E-05	1.5E+00	0.0000066
Cobalt	13.3	0.000436	0.0547	0.000462	0.0552	3.6E-04	3.0E-04	**1.2**
Manganese	3,990	0.456	1.75	0.00967	1.76	1.1E-02	1.4E-01	0.082
Molybdenum	NA	0.0239	NA	0.00760	0.00760	5.0E-05	5.0E-03	0.0099
Nickel	230	NA	0.497	NA	0.497	3.2E-03	2.0E-02	0.16
Selenium	29.0	0.00267	0.0979	0.00212	0.100	6.5E-04	5.0E-03	0.13
Thallium	1.30	0.000200	0.00747	0.000424	0.00790	5.1E-05	1.0E-05	**5.1**
Uranium	42.0	NA	0.00135	NA	0.00135	8.8E-06	2.0E-04	0.044
Vanadium	370	NA	0.138	NA	0.138	9.0E-04	5.0E-03	0.18
							HI	**8**

Notes:

[a] Maximum detected concentration measured in upland soil and groundwater samples collected from background sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	mg/L	milligrams per liter
HQ	hazard quotient	NA	not applicable
mg/kg	milligrams per kilogram		

Table C-40
Summary of Tier I Background Human Health Risk Estimates - Cattle - Upland Soil and Groundwater

Analyte	Upland Soil Concentration[a] (mg/kg)			Groundwater Concentration[a] (mg/L)			Modeled Cattle Concentration (mg/kg)	Current/Future Seasonal Rancher	
	Maximum	95% UCL	EPC[b]	Maximum	95% UCL	EPC[b]	EPC[c]	ILCR	HQ
Antimony	3.60	NA	3.60	NA	NA	NA	0.00325	NA	0.053
Arsenic	19.0	NA	19.0	0.000989	NA	0.000989	0.0109	**3.6E-05**	0.24
Cadmium	44.0	NA	44.0	NA	NA	NA	0.0499	NA	0.33
Chromium	NA	NA	NA	0.00524	NA	0.00524	0.00153	NA	0.0000066
Cobalt	13.3	NA	13.3	0.000436	NA	0.000436	0.0552	NA	**1.2**
Manganese	3,990	NA	3,990	0.456	NA	0.456	1.76	NA	0.082
Molybdenum	NA	NA	NA	0.0239	NA	0.0239	0.00760	NA	0.0099
Nickel	230	NA	230	NA	NA	NA	0.497	NA	0.16
Selenium	29.0	NA	29.0	0.00267	NA	0.00267	0.100	NA	0.13
Thallium	1.30	NA	1.30	0.000200	NA	0.000200	0.00790	NA	**5.1**
Uranium	42.0	NA	42.0	NA	NA	NA	0.00135	NA	0.044
Vanadium	370	NA	370	NA	NA	NA	0.138	NA	0.18
Cumulative ILCR/HQ:								**4E-05**	**8**
IDEQ Point of Departure:								10^{-5}	1
USEPA Risk Range:								10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration measured in upland soil and groundwater samples collected from background sampling locations.

[b] The upland soil and groundwater EPCs used to model cattle concentration are the maximum detected concentrations in those media.

[d] The cattle EPC was modeled from upland soil and groundwater EPCs.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
mg/L - milligrams per liter
NA - not applicable
USEPA - U. S. Environmental Protection Agency

Table C-41
Tier I Background Cancer Risk Calculation for a Current/Future Native American - Culturally Significant Aquatic Plants

Analyte	Sediment Concentration[a] (mg/kg)	Surface Water Concentration[a] (mg/L)	Modeled Culturally Significant Aquatic Plant Concentration from Sediment (mg/kg dry weight)	Modeled Culturally Significant Aquatic Plant Concentration from Sediment [b] (mg/kg wet weight)	Modeled Plant Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [c] Oral	Chemical-Specific Risk
Arsenic	4.55	0.00110	0.171	0.0585	1.3E-04	1.5E+00	**2.0E-04**
						ILCR	**2E-04**

Notes:

[a] Maximum detected concentration measured in sediment or surface water samples collected from background sampling locations.

[b] Dry weight plant concentrations were converted to wet weight plant concentrations assuming a plant moisture content of 65.7 percent.

[c] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

95% UCL 95 percent upper confidence limit
ILCR incremental lifetime cancer risk
mg/kg milligrams per kilogram
mg/kg-d milligrams per kilogram per day
mg/L milligrams per liter

Table C-42
Tier I Background Noncancer Hazard Calculation for a Current/Future Native American - Culturally Significant Aquatic Plants

Analyte	Sediment Concentration[a] (mg/kg)	Surface Water Concentration (mg/L)	Modeled Culturally Significant Aquatic Plant Concentration from Sediment (mg/kg dry weight)	Modeled Culturally Significant Aquatic Plant Concentration from Sediment [b] (mg/kg wet weight)	Modeled Plant Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [c] Oral	Chemical-Specific HQ
Antimony	5.00	NA	0.178	0.0611	3.2E-04	4.0E-04	0.80
Arsenic	4.55	0.00110	0.171	0.0585	3.0E-04	3.0E-04	1.0
Cadmium	3.74	0.000100	1.28	0.438	2.3E-03	1.0E-03	**2.3**
Chromium	34.8	0.00393	1.43	0.489	2.5E-03	1.5E+00	0.0017
Manganese	405	0.0484	32.0	11.0	5.7E-02	1.4E-01	0.41
Nickel	24.4	0.00221	1.18	0.405	2.1E-03	2.0E-02	0.11
Selenium	1.60	0.00100	0.854	0.292	1.5E-03	5.0E-03	0.30
Thallium	0.378	0.000150	0.00151	0.000518	2.7E-06	1.0E-05	0.27
Uranium	2.37	NA	0.0201	0.00690	3.6E-05	2.0E-04	0.18
Vanadium	45.2	0.00620	0.219	0.0751	3.9E-04	5.0E-03	0.078
Zinc	151	0.0150	77.8	26.7	1.4E-01	3.0E-01	0.46
						HI	**6**

Notes:

[a] Maximum detected concentration measured in sediment or surface water samples collected from background sampling locations.

[b] Dry weight plant concentrations were converted to wet weight plant concentrations assuming a plant moisture content of 65.7 percent.

[c] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

95% UCL	95 percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	mg/L	milligrams per liter
HQ	hazard quotient	NA	not applicable
mg/kg	milligrams per kilogram		

Table C-43
Summary of Tier I Background Human Health Risk Estimates - Culturally Significant Aquatic Plants

Analyte	Sediment Concentration[a] (mg/kg) Maximum	95% UCL	EPC[b]	Surface Water Concentration[a] (mg/L) Maximum	95% UCL	EPC	Modeled Culturally Significant Aquatic Plants Concentration (mg/kg) EPC[c]	Current/Future Native American ILCR	HQ
Antimony	5.00	NA	5.00	NA	NA	NA	0.0611	NA	0.80
Arsenic	4.55	NA	4.55	0.00110	NA	0.00110	0.0585	**2.0E-04**	1.0
Cadmium	3.74	NA	3.74	0.000100	NA	0.000100	0.438	NA	**2.3**
Chromium	34.8	NA	34.8	0.00393	NA	0.00393	0.489	NA	0.0017
Manganese	405	NA	405	0.0484	NA	0.0484	11.0	NA	0.41
Nickel	24.4	NA	24.4	0.00221	NA	0.00221	0.405	NA	0.11
Selenium	1.60	NA	1.60	0.00100	NA	0.00100	0.292	NA	0.30
Thallium	0.378	NA	0.378	0.000150	NA	0.000150	0.000518	NA	0.27
Uranium	2.37	NA	2.37	NA	NA	NA	0.00690	NA	0.18
Vanadium	45.2	NA	45.2	0.00620	NA	0.00620	0.0751	NA	0.078
Zinc	151	NA	151	0.0150	NA	0.0150	26.7	NA	0.46
							Cumulative ILCR/HQ:	**2E-04**	**6**
							IDEQ Point of Departure:	10^{-5}	1
							USEPA Risk Range:	10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration measured in sediment or surface water samples collected from background sampling locations.

[b] The sediment EPC used to model culturally significant aquatic plants concentration is the maximum detected concentration.

[c] The culturally significant aquatic plants EPCs for surface water constituents of potential concern were modeled from the sediment EPCs using sediment-to-plant uptake factors when sediment data were available.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
mg/L - milligrams per liter
NA - not applicable
USEPA - U. S. Environmental Protection Agency

Table C-44
Tier I Background Cancer Risk Calculation - Fish Consumption
Recreational Fisher, Native American and Hypothetical Future Resident

Analyte	Sediment Concentration[a] (mg/kg)	Surface Water Concentration[a] (mg/L)	Modeled Fish Concentration from Sediment (mg/kg wet weight)	Modeled Fish Concentration from Surface Water (mg/kg wet weight)	Fish Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Chemical-Specific Risk
Arsenic	4.55	0.00110	0.0109	0.125	2.7E-05	1.5E+00	**4.1E-05**
						ILCR	**4E-05**

Notes:

[a] Maximum detected concentration measured in sediment or surface water samples collected from background sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

95% UCL 95 percent upper confidence limit
ILCR incremental lifetime cancer risk
mg/kg milligrams per kilogram
mg/kg-d milligrams per kilogram per day
mg/L milligrams per liter

Table C-45
Tier I Background Noncancer Hazard Calculation - Fish Consumption
Recreational Fisher, Native American and Hypothetical Future Resident

Analyte	Sediment Concentration[a] (mg/kg)	Surface Water Concentration (mg/L)	Modeled Fish Concentration from Sediment (mg/kg wet weight)	Modeled Fish Concentration from Surface Water (mg/kg wet weight)	Fish Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Chemical-Specific HQ
Antimony	5.00	NA	5.00	NA	2.5E-03	4.0E-04	**6.4**
Arsenic	4.55	0.00110	0.0109	0.125	6.4E-05	3.0E-04	0.21
Cadmium	3.74	0.000100	0.587	0.0907	4.6E-05	1.0E-03	0.046
Chromium	34.8	0.00393	0.299	0.0747	3.8E-05	1.5E+00	0.000025
Cobalt	NA	0.0100	NA	0.0100	5.1E-06	3.0E-04	0.017
Manganese	405	0.0484	405	0.0484	2.5E-05	1.4E-01	0.00018
Nickel	24.4	0.00221	24.4	0.172	8.8E-05	2.0E-02	0.0044
Selenium	1.60	0.00100	1.60	0.129	6.6E-05	5.0E-03	0.013
Thallium	0.378	0.000150	0.378	1.50	7.6E-04	1.0E-05	**76**
Uranium	2.37	0.00120	2.37	0.00120	6.1E-07	2.0E-04	0.0030
Vanadium	45.2	0.00620	45.2	0.00620	3.2E-06	5.0E-03	0.00063
Zinc	151	0.0150	55.4	30.9	1.6E-02	3.0E-01	0.052
						HI	**83**

Notes:

[a] Maximum detected concentration measured in sediment or surface water samples collected from background sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

95% UCL	95 percent upper confidence limit
HI	hazard index
HQ	hazard quotient
mg/kg	milligrams per kilogram
mg/kg-d	milligrams per kilogram per day
mg/L	milligrams per liter
NA	not applicable

Table C-46
Summary of Tier I Background Human Health Risk Estimates - Fish

Analyte	Sediment Concentration[a] (mg/kg)			Surface Water Concentration[a] (mg/L)			Modeled Fish Concentration (mg/kg)	Current/Future Recreational Fisher and Native American and Hypothetical Future Resident	
	Maximum	95% UCL	EPC[b]	Maximum	95% UCL	EPC[b]	EPC[c]	ILCR	HQ
Antimony	5.00	NA	5.00	NA	NA	NA	5.00	NA	**6.4**
Arsenic	4.55	NA	4.55	0.00110	NA	0.00110	0.125	**4.1E-05**	0.21
Cadmium	3.74	NA	3.74	0.000100	NA	0.000100	0.0907	NA	0.046
Chromium	34.8	NA	34.8	0.00393	NA	0.00393	0.0747	NA	0.000025
Cobalt	NA	NA	NA	0.0100	NA	0.0100	0.0100	NA	0.017
Manganese	405	NA	405	0.0484	NA	0.0484	0.0484	NA	0.00018
Nickel	24.4	NA	24.4	0.00221	NA	0.00221	0.172	NA	0.0044
Selenium	1.60	NA	1.60	0.00100	NA	0.00100	0.129	NA	0.013
Thallium	0.378	NA	0.378	0.000150	NA	0.000150	1.50	NA	**76**
Uranium	2.37	NA	2.37	0.00120	NA	0.00120	0.00120	NA	0.0030
Vanadium	45.2	NA	45.2	0.00620	NA	0.00620	0.00620	NA	0.00063
Zinc	151	NA	151	0.0150	NA	0.0150	30.9	NA	0.052
Cumulative ILCR/HQ:								**4E-05**	**83**
IDEQ Point of Departure:								10^{-5}	1
USEPA Risk Range:								10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration measured in sediment or surface water samples collected from background sampling locations.

[b] The sediment or surface water EPC used to model the fish concentration is the maximum detected concentration.

[c] The fish EPCs for both surface water and sediment constituents of potential concern were modeled from the surface water EPCs using surface water-to-fish uptake factors when surface water data were available, otherwise they were modeled from the sediment EPCs using sediment-to-fish uptake factors.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk

mg/kg - milligrams per kilogarm
mg/L - milligrams per liter
NA - not applicable
na - not available
USEPA - U. S. Environmental Protection Agency

Table C-47

Tier I Background Radiological Risk Calculation for a Current/Future Native American

Medium	Radium-226 EPC[a]		Pathway-Specific Radium-226 PRG [b]		Pathway-Specific Radium-226 Risk	Total Medium Radium-226 Risk
Culturally Significant Plants						
Upland Soil	27.2	pCi/g	0.0248	pCi/g	**1.1E-03**	**1.1E-03**
Elk						
Upland Soil	27.2	pCi/g	57.3	pCi/g	4.8E-07	4.8E-07
Upland Soil						
Incidental Ingestion	27.2	pCi/g	1.53	pCi/g	**1.8E-05**	**4.4E-04**
External Exposure	27.2	pCi/g	0.0650	pCi/g	**4.2E-04**	
Inhalation of Particulates	27.2	pCi/g	19,400	pCi/g	1.4E-09	
Aquatic Plants [c]						
Sediment	1.65	pCi/g	0.0474	pCi/g	**3.5E-05**	**3.5E-05**
Fish						
Surface Water	0.417	pCi/L	1.71	pCi/L	2.4E-07	2.4E-07
					Total Site Media Risk:	**2E-03**
					IDEQ Point-of-departure:	**10^{-5}**
					USEPA Risk Range:	**10^{-6} - 10^{-4}**

Notes:

[a] The upland soil EPC was calculated from gamma count measurements at background sample locations according to the regression model described in the on-site and background areas radiological and soil investigation summary report (MWH, 2015). The surface water EPC was calculated from total uranium based on an assumption of secular equilibrium (i.e., 1 pCi/L uranium-238 is equivalent to 1 pCi/L radium-226), a natural abundance of uranium-238 of 49% of total uranium (ATSDR, 2013), and a unit conversion of 7.1×10^5 pCi/g based on the activity of natural uranium (49 CFR 173.434). The sediment EPC was calculated based on the same total uranium to radium-226 conversion factor used to calculate water EPCs, with an additional uranium-238 to radium-226 ratio of 0.5 to 1, based on the approximate mean ratio for upland soils described in MWH (2015), applied.

[b] Preliminary Remediation Goals (PRGs) for radium-226+daughter products were calculated using the USEPA's online PRG calculator for radionuclides.

[c] Consistent with the evaluation for metals, the cumulative ILCR for the Native American includes the larger of the ILCR for radium-226 in upland or aquatic culturally significant plants. Because the PRG for aquatic plants is greater than the PRG for upland plants, aquatic plants are not included in the cumulative ILCR.

Bold indicates ILCR estimates above USEPA's risk management range or IDEQ's point of departure

EPC - Exposure point concentration
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
pCi/g - picocuries per gram
pCi/L - picocuries per liter
PRG - Preliminary Remediation Goal
USEPA - United States Environmental Protection Agency

Table C-48

Tier I Background Radiological Risk Calculation for a Hypothetical Future Resident

Medium	Radium-226 EPC[a]		Pathway-Specific Radium-226 PRG [b]		Pathway-Specific Radium-226 Risk	Total Medium Radium-226 Risk
Fruits and Vegetables						
Upland Soil	27.2	pCi/g	0.0248	pCi/g	**1.1E-03**	**1.1E-03**
Upland Soil						
Incidental Ingestion	27.2	pCi/g	1.53	pCi/g	**1.8E-05**	**4.4E-04**
External Exposure	27.2	pCi/g	0.0650	pCi/g	**4.2E-04**	
Inhalation of Particulates	27.2	pCi/g	19,400	pCi/g	1.4E-09	
Fish						
Surface Water	0.417	pCi/L	1.71	pCi/L	2.4E-07	2.4E-07
Medium	**Radon-222 EPC[a]**		**Pathway-Specific Radon-222 PRG [b]**		**Pathway-Specific Radon-222 Risk**	**Total Medium Radon-222 Risk**
Indoor Air	12,684	pCi/m^3	0.242	pCi/m^3	**5.2E-02**	**5.2E-02**
					Total Site Media Risk:	**5E-02**
					IDEQ Point-of-departure:	**10^{-5}**
					USEPA Risk Range:	**10^{-6} - 10^{-4}**

Notes:

[a] The upland soil EPC was calculated from gamma count measurements at background sample locations according to the regression model described in the on-site and background areas radiological and soil investigation summary report (MWH, 2015). The surface water EPC was calculated from total uranium based on an assumption of secular equilibrium (i.e., 1 pCi/L uranium-238 is equivalent to 1 pCi/L radium-226), a natural abundance of uranium-238 of 49% of total uranium (ATSDR, 2013), and a unit conversion of 7.1x105 pCi/g based on the activity of natural uranium (49 CFR 173.434). The indoor air EPC was calculated from radon flux measurements from background sample locations (MWH, 2015).

[b] Preliminary Remediation Goals (PRGs) for radium-226+daughter products and radon-222+daughter products were calculated using the USEPA's online PRG calculator for radionuclides.

Bold indicates ILCR estimates above USEPA's risk management range or IDEQ's point of departure

EPC - Exposure point concentration
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
NA - not applicable
pCi/g - picocuries per gram
pCi/L - picocuries per liter
PRG - Preliminary Remediation Goal
USEPA - United States Environmental Protection Agency

Table C-49

Tier I Background Radiological Risk Calculation for a Current/Future Seasonal Rancher

Medium	Radium-226 EPC[a]		Pathway-Specific Radium-226 PRG [b]		Pathway-Specific Radium-226 Risk	Total Medium Radium-226 Risk
Cattle						
Upland Soil	27.2	pCi/g	0.631	pCi/g	**4.3E-05**	**4.3E-05**
Upland Soil						
Incidental Ingestion	27.2	pCi/g	5.15	pCi/g	**5.3E-06**	**9.0E-04**
External Exposure	27.2	pCi/g	0.0304	pCi/g	**9.0E-04**	
Inhalation of Particulates	27.2	pCi/g	8,190	pCi/g	3.3E-09	
					Total Site Media Risk:	**9E-04**
					IDEQ Point-of-departure:	**10^{-5}**
					USEPA Risk Range:	**10^{-6} - 10^{-4}**

Notes:

[a] The upland soil EPC was calculated from gamma count measurements at background sample locations according to the regression model described in the on-site and background areas radiological and soil investigation summary report (MWH, 2015).

[b] Preliminary Remediation Goals (PRGs) for radium-226+daughter products were calculated using the USEPA's online PRG calculator for radionuclides.

Bold indicates ILCR estimates above USEPA's risk management range or IDEQ's point of departure

EPC - Exposure point concentration
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
NA - not applicable
pCi/g - picocuries per gram
pCi/L - picocuries per liter
PRG - Preliminary Remediation Goal
USEPA - United States Environmental Protection Agency

ATTACHMENT D – TIER II HENRY SITE

CTE AND RME HUMAN HEALTH RISK CALCULATIONS

Table D-1
Tier II CTE Henry Site Cancer Risk Calculation for a Current/Future Native American - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Dust Inhalation Dose (ug/m^3)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Dermal	URF $(ug/m^3)^{-1}$ [b] Inhalation	Pathway-Specific Cancer Risk Soil Ingestion	Pathway-Specific Cancer Risk Dermal	Pathway-Specific Cancer Risk Dust Inhalation	Chemical-Specific Risk
Arsenic	24.9	1.6E-06	2.2E-07	9.2E-09	1.5E+00	1.5E+00	4.3E-03	2.4E-06	3.4E-07	4.0E-11	**2.8E-06**
										ILCR	**3E-06**

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL	percent upper confidence limit
ILCR	incremental lifetime cancer risk
mg/kg	milligrams per kilogram
mg/kg-d	milligrams per kilogram per day
CTE	central tendency exposure
URF	unit risk factor
ug/m^3	microgram per cubic meter

Table D-2
Tier II CTE Henry Site Noncancer Hazard Calculation for a Current/Future Native American - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Dust Inhalation Dose (mg/m^3)	Reference Dose (mg/kg-d) [b]		RfC (mg/m^3) [b]	Pathway-Specific Hazard			Chemical-Specific HQ
					Oral	Dermal	Inhalation	Soil Ingestion	Dermal	Dust Inhalation	
Arsenic	24.9	1.4E-05	2.0E-06	8.1E-11	3.0E-04	3.0E-04	1.5E-05	4.8E-02	6.5E-03	5.4E-06	0.054
Uranium	40.5	3.9E-05	1.0E-06	1.3E-10	2.0E-04	2.0E-04	4.0E-05	1.9E-01	5.0E-03	3.3E-06	0.20
Vanadium	212	2.0E-04	5.2E-06	6.9E-10	5.0E-03	1.3E-04	1.0E-04	4.0E-02	4.0E-02	6.9E-06	0.081
										HI	0.3

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL — percent upper confidence limit
HI — hazard index
HQ — hazard quotient
mg/kd-d — milligrams per kilogram per day
mg/m^3 — milligram per cubic meter
RfC — reference concentration
CTE — central tendency exposure

Table D-3
Tier II CTE Henry Site Cancer Risk Calculation for a Hypothetical Future Resident - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Inhalation Dose (ug/m^3)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Dermal	URF $(ug/m^3)^{-1}$ [b] Inhalation	Pathway-Specific Cancer Risk: Soil Ingestion	Pathway-Specific Cancer Risk: Dermal	Pathway-Specific Cancer Risk: Inhalation	Chemical-Specific Risk
Arsenic	24.9	1.6E-06	2.2E-07	9.2E-09	1.5E+00	1.5E+00	4.3E-03	2.4E-06	3.4E-07	4.0E-11	**2.8E-06**
										ILCR	**3E-06**

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL	percent upper confidence limit	CTE	central tendency exposure
ILCR	incremental lifetime cancer risk	URF	unit risk factor
mg/kg	milligrams per kilogram	ug/m^3	microgram per cubic meter
mg/kg-d	milligrams per kilogram per day		

Table D-4
Tier II CTE Henry Site Noncancer Hazard Calculation for a Hypothetical Future Resident - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Inhalation Dose (mg/m^3)	Reference Dose (mg/kg-d) [b]		RfC (mg/m^3) [b]	Pathway-Specific Hazard			Chemical-Specific HQ
					Oral	Dermal	Inhalation	Soil Ingestion	Dermal	Inhalation	
Arsenic	24.9	1.4E-05	2.0E-06	8.1E-11	3.0E-04	3.0E-04	1.5E-05	4.8E-02	6.5E-03	5.4E-06	0.054
Uranium	40.5	3.9E-05	1.0E-06	1.3E-10	2.0E-04	2.0E-04	4.0E-05	1.9E-01	5.0E-03	3.3E-06	0.20
Vanadium	212	2.0E-04	5.2E-06	6.9E-10	5.0E-03	1.3E-04	1.0E-04	4.0E-02	4.0E-02	6.9E-06	0.081
										HI	0.3

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL	percent upper confidence limit
HI	hazard index
HQ	hazard quotient
mg/kg	milligrams per kilogram
mg/kd-d	milligrams per kilogram per day
mg/m^3	milligram per cubic meter
RfC	reference concentration
CTE	central tendency exposure

Table D-5
Tier II CTE Henry Site Cancer Risk Calculation for a Current/Future Seasonal Rancher - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Dust Inhalation Dose (ug/m^3)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b]		URF $(ug/m^3)^{-1}$ [b]	Pathway-Specific Cancer Risk			Chemical-Specific Risk
					Oral	Dermal	Inhalation	Soil Ingestion	Dermal	Dust Inhalation	
Arsenic	24.9	2.4E-07	1.3E-07	1.4E-08	1.5E+00	1.5E+00	4.3E-03	3.6E-07	2.0E-07	6.2E-11	5.6E-07
										ILCR	6E-07

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL	percent upper confidence limit	CTE	central tendency exposure
ILCR	incremental lifetime cancer risk	URF	unit risk factor
mg/kg	milligrams per kilogram	ug/m^3	microgram per cubic meter
mg/kg-d	milligrams per kilogram per day		

Table D-6
Tier II CTE Henry Site Noncancer Hazard Calculation for a Current/Future Seasonal Rancher - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Dust Inhalation Dose (mg/m^3)	Reference Dose (mg/kg-d) [b]		RfC (mg/m^3) [b]	Pathway-Specific Hazard			Chemical-Specific HQ
					Oral	Dermal	Inhalation	Soil Ingestion	Dermal	Dust Inhalation	
Arsenic	24.9	2.6E-06	1.4E-06	1.6E-10	3.0E-04	3.0E-04	1.5E-05	8.8E-03	4.8E-03	1.1E-05	0.014
Uranium	40.5	7.1E-06	7.3E-07	2.6E-10	2.0E-04	2.0E-04	4.0E-05	3.6E-02	3.6E-03	6.4E-06	0.039
Vanadium	212	3.7E-05	3.8E-06	1.4E-09	5.0E-03	1.3E-04	1.0E-04	7.5E-03	2.9E-02	1.4E-05	0.037
										HI	0.09

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL	percent upper confidence limit	mg/m^3	milligram per cubic meter
HI	hazard index	RfC	reference concentration
HQ	hazard quotient	CTE	central tendency exposure
mg/kg	milligrams per kilogram		
mg/kd-d	milligrams per kilogram per day		

Table D-7
Tier II CTE Henry Site Cancer Risk Calculation for a Current/Future Hunter - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Dust Inhalation Dose (ug/m^3)	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b]		URF (ug/m^3)$^{-1}$ [b]	Pathway-Specific Cancer Risk			Chemical-Specific Risk
					Oral	Dermal	Inhalation	Soil Ingestion	Dermal	Dust Inhalation	
Arsenic	24.9	2.1E-08	1.2E-08	3.9E-09	1.5E+00	1.5E+00	4.3E-03	3.2E-08	1.7E-08	1.7E-11	4.9E-08
										ILCR	5E-08

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL	percent upper confidence limit	CTE	central tendency exposure
ILCR	incremental lifetime cancer risk	URF	unit risk factor
mg/kg	milligrams per kilogram	ug/m^3	microgram per cubic meter
mg/kg-d	milligrams per kilogram per day		

Table D-8
Tier II CTE Henry Site Noncancer Hazard Calculation for a Current/Future Hunter - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Dust Inhalation Dose (mg/m^3)	Reference Dose (mg/kg-d) [b] Oral	Reference Dose (mg/kg-d) [b] Dermal	RfC (mg/m^3) [b] Inhalation	Pathway-Specific Hazard Soil Ingestion	Pathway-Specific Hazard Dermal	Pathway-Specific Hazard Dust Inhalation	Chemical-Specific HQ
Arsenic	24.9	2.3E-07	1.3E-07	4.2E-11	3.0E-04	3.0E-04	1.5E-05	7.8E-04	4.2E-04	2.8E-06	0.0012
Uranium	40.5	6.3E-07	6.5E-08	6.9E-11	2.0E-04	2.0E-04	4.0E-05	3.2E-03	3.2E-04	1.7E-06	0.0035
Vanadium	212	3.3E-06	3.4E-07	3.6E-10	5.0E-03	1.3E-04	1.0E-04	6.6E-04	2.6E-03	3.6E-06	0.0033
										HI	0.008

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL	percent upper confidence limit	mg/m^3	milligram per cubic meter
HI	hazard index	RfC	reference concentration
HQ	hazard quotient	CTE	central tendency exposure
mg/kg	milligrams per kilogram		
mg/kd-d	milligrams per kilogram per day		

Table D-9
Tier II CTE Henry Site Cancer Risk Calculation for a Recreational Camper/Hiker - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Inhalation Dose (ug/m^3)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Dermal	URF $(ug/m^3)^{-1}$ [b] Inhalation	Pathway-Specific Cancer Risk Soil Ingestion	Pathway-Specific Cancer Risk Dermal	Pathway-Specific Cancer Risk Inhalation	Chemical-Specific Risk
Arsenic	24.9	2.8E-08	1.4E-09	1.8E-09	1.5E+00	1.5E+00	4.3E-03	4.1E-08	2.1E-09	7.8E-12	4.3E-08
										ILCR	4E-08

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL	percent upper confidence limit	na	not available
ILCR	incremental lifetime cancer risk	CTE	central tendency exposure
mg/kg	milligrams per kilogram	URF	unit risk factor
mg/kg-d	milligrams per kilogram per day	ug/m^3	microgram per cubic meter

Table D-10
Tier II CTE Henry Site Noncancer Hazard Calculation for a Recreational Camper/Hiker - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Inhalation Dose (mg/m^3)	Reference Dose (mg/kg-d) [b] Oral	Reference Dose (mg/kg-d) [b] Dermal	RfC (mg/m^3) [b] Inhalation	Pathway-Specific Hazard Soil Ingestion	Pathway-Specific Hazard Dermal	Pathway-Specific Hazard Inhalation	Chemical-Specific HQ
Arsenic	24.9	2.4E-07	1.3E-08	1.6E-11	3.0E-04	3.0E-04	1.5E-05	8.0E-04	4.2E-05	1.1E-06	0.00085
Uranium	40.5	6.5E-07	6.4E-09	2.6E-11	2.0E-04	2.0E-04	4.0E-05	3.3E-03	3.2E-05	6.4E-07	0.0033
Vanadium	212	3.4E-06	3.3E-08	1.4E-10	5.0E-03	1.3E-04	1.0E-04	6.8E-04	2.6E-04	1.4E-06	0.00094
										HI	0.005

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL	percent upper confidence limit	mg/m^3	milligram per cubic meter
HI	hazard index	na	not available
HQ	hazard quotient	RfC	reference concentration
mg/kg	milligrams per kilogram	CTE	central tendency exposure
mg/kd-d	milligrams per kilogram per day		

Table D-11
Summary of Tier II CTE Henry Site Human Health Risk Estimates - Upland Soil

Analyte	Concentration[a] (mg/kg)			Current/Future Native American		Hypothetical Future Resident		Current/Future Seasonal Rancher		Current/Future Recreational Hunter		Current/Future Recreational Camper/Hiker	
	Maximum	**95% UCL**	**EPC[b]**	**ILCR**	**HQ**	**ILCR**	**HQ**	**ILCR**	**HQ**	**ILCR**	**HQ**	**ILCR**	**HQ**
Arsenic	45.5	24.9	24.9	**2.8E-06**	0.054	**2.8E-06**	0.054	5.6E-07	0.014	4.9E-08	0.0012	4.3E-08	0.00085
Uranium	74.4	40.5	40.5	NA	0.20	NA	0.20	NA	0.039	NA	0.0035	NA	0.0033
Vanadium	584	212	212	NA	0.081	NA	0.081	NA	0.037	NA	0.0033	NA	0.00094
Cumulative ILCR/HQ:				**3E-06**	0.3	**3E-06**	0.3	6E-07	0.09	5E-08	0.008	4E-08	0.005
IDEQ Point of Departure:				10^{-5}	1								
USEPA Risk Range:				10^{-6} - 10^{-4}	1								

Notes:

[a] Maximum detected concentration and ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] The exposure point concentration (EPC) either the 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
NA - not applicable
USEPA - U. S. Environmental Protection Agency
CTE - central tendency exposure

Table D-12
Tier II RME Henry Site Cancer Risk Calculation for a Current/Future Native American - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Dust Inhalation Dose (ug/m^3)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Dermal	URF $(ug/m^3)^{-1}$ [b] Inhalation	Pathway-Specific Cancer Risk Soil Ingestion	Pathway-Specific Cancer Risk Dermal	Pathway-Specific Cancer Risk Dust Inhalation	Chemical-Specific Risk
Arsenic	24.9	1.8E-05	1.3E-05	1.0E-07	1.5E+00	1.5E+00	4.3E-03	2.7E-05	2.0E-05	4.4E-10	**4.7E-05**
										ILCR	**5E-05**

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL	percent upper confidence limit
ILCR	incremental lifetime cancer risk
mg/kg	milligrams per kilogram
mg/kg-d	milligrams per kilogram per day
RME	reasonable maximum exposure
URF	unit risk factor
ug/m^3	microgram per cubic meter

Table D-13
Tier II RME Henry Site Noncancer Hazard Calculation for a Current/Future Native American - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Dust Inhalation Dose (mg/m^3)	Reference Dose (mg/kg-d) [b] Oral	Reference Dose (mg/kg-d) [b] Dermal	RfC (mg/m^3) [b] Inhalation	Pathway-Specific Hazard Soil Ingestion	Pathway-Specific Hazard Dermal	Pathway-Specific Hazard Dust Inhalation	Chemical-Specific HQ
Arsenic	24.9	4.2E-05	3.1E-05	2.4E-10	3.0E-04	3.0E-04	1.5E-05	1.4E-01	1.0E-01	1.6E-05	0.24
Uranium	40.5	1.1E-04	1.6E-05	3.9E-10	2.0E-04	2.0E-04	4.0E-05	5.7E-01	7.8E-02	9.7E-06	0.65
Vanadium	212	6.0E-04	8.1E-05	2.0E-09	5.0E-03	1.3E-04	1.0E-04	1.2E-01	6.3E-01	2.0E-05	0.74
										HI	2

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL	percent upper confidence limit	mg/m^3	milligram per cubic meter
HI	hazard index	RfC	reference concentration
HQ	hazard quotient	RME	reasonable maximum exposure
mg/kd-d	milligrams per kilogram per day		

Table D-14
Tier II RME Henry Site Cancer Risk Calculation for a Hypothetical Future Resident - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Inhalation Dose (ug/m^3)	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b] Oral	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b] Dermal	URF (ug/m^3)$^{-1}$ [b] Inhalation	Pathway-Specific Cancer Risk Soil Ingestion	Pathway-Specific Cancer Risk Dermal	Pathway-Specific Cancer Risk Inhalation	Chemical-Specific Risk
Arsenic	24.9	1.8E-05	1.3E-05	1.0E-07	1.5E+00	1.5E+00	4.3E-03	2.7E-05	2.0E-05	4.4E-10	**4.7E-05**
										ILCR	**5E-05**

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL	percent upper confidence limit
ILCR	incremental lifetime cancer risk
mg/kg	milligrams per kilogram
mg/kg-d	milligrams per kilogram per day
RME	reasonable maximum exposure
URF	unit risk factor
ug/m^3	microgram per cubic meter

Table D-15
Tier II RME Henry Site Noncancer Hazard Calculation for a Hypothetical Future Resident - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Inhalation Dose (mg/m^3)	Reference Dose (mg/kg-d) [b]		RfC (mg/m^3) [b]	Pathway-Specific Hazard			Chemical-Specific HQ
					Oral	Dermal	Inhalation	Soil Ingestion	Dermal	Inhalation	
Arsenic	24.9	4.2E-05	3.1E-05	2.4E-10	3.0E-04	3.0E-04	1.5E-05	1.4E-01	1.0E-01	1.6E-05	0.24
Uranium	40.5	1.1E-04	1.6E-05	3.9E-10	2.0E-04	2.0E-04	4.0E-05	5.7E-01	7.8E-02	9.7E-06	0.65
Vanadium	212	6.0E-04	8.1E-05	2.0E-09	5.0E-03	1.3E-04	1.0E-04	1.2E-01	6.3E-01	2.0E-05	0.74
										HI	2

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL	percent upper confidence limit	mg/m^3	milligram per cubic meter
HI	hazard index	RfC	reference concentration
HQ	hazard quotient	RME	reasonable maximum exposure
mg/kg	milligrams per kilogram		
mg/kd-d	milligrams per kilogram per day		

Table D-16
Tier II RME Henry Site Cancer Risk Calculation for a Current/Future Seasonal Rancher - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Dust Inhalation Dose (ug/m^3)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Dermal	URF $(ug/m^3)^{-1}$ [b] Inhalation	Pathway-Specific Cancer Risk: Soil Ingestion	Pathway-Specific Cancer Risk: Dermal	Pathway-Specific Cancer Risk: Dust Inhalation	Chemical-Specific Risk
Arsenic	24.9	2.4E-06	2.9E-06	2.2E-07	1.5E+00	1.5E+00	4.3E-03	3.6E-06	4.4E-06	9.3E-10	**8.0E-06**
										ILCR	**8E-06**

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL percent upper confidence limit
ILCR incremental lifetime cancer risk
mg/kg milligrams per kilogram
mg/kg-d milligrams per kilogram per day
RME reasonable maximum exposure
URF unit risk factor
ug/m^3 microgram per cubic meter

Table D-17
Tier II RME Henry Site Noncancer Hazard Calculation for a Current/Future Seasonal Rancher - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Dust Inhalation Dose (mg/m^3)	Reference Dose (mg/kg-d) [b] Oral	Reference Dose (mg/kg-d) [b] Dermal	RfC (mg/m^3) [b] Inhalation	Pathway-Specific Hazard Soil Ingestion	Pathway-Specific Hazard Dermal	Pathway-Specific Hazard Dust Inhalation	Chemical-Specific HQ
Arsenic	24.9	7.0E-06	8.5E-06	6.3E-10	3.0E-04	3.0E-04	1.5E-05	2.3E-02	2.8E-02	4.2E-05	0.052
Uranium	40.5	1.9E-05	4.3E-06	1.0E-09	2.0E-04	2.0E-04	4.0E-05	9.5E-02	2.2E-02	2.6E-05	0.12
Vanadium	212	1.0E-04	2.3E-05	5.4E-09	5.0E-03	1.3E-04	1.0E-04	2.0E-02	1.7E-01	5.4E-05	0.19
										HI	0.4

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL percent upper confidence limit
HI hazard index
HQ hazard quotient
mg/kg milligrams per kilogram
mg/kd-d milligrams per kilogram per day
mg/m^3 milligram per cubic meter
RfC reference concentration
RME reasonable maximum exposure

Table D-18
Tier II RME Henry Site Cancer Risk Calculation for a Current/Future Hunter - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Dust Inhalation Dose (ug/m^3)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Dermal	URF $(ug/m^3)^{-1}$ [b] Inhalation	Pathway-Specific Cancer Risk Soil Ingestion	Pathway-Specific Cancer Risk Dermal	Pathway-Specific Cancer Risk Dust Inhalation	Chemical-Specific Risk
Arsenic	24.9	2.8E-07	2.5E-07	5.1E-08	1.5E+00	1.5E+00	4.3E-03	4.2E-07	3.8E-07	2.2E-10	8.0E-07
										ILCR	8E-07

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL	percent upper confidence limit
ILCR	incremental lifetime cancer risk
mg/kg	milligrams per kilogram
mg/kg-d	milligrams per kilogram per day
RME	reasonable maximum exposure
URF	unit risk factor
ug/m^3	microgram per cubic meter

Table D-19
Tier II RME Henry Site Noncancer Hazard Calculation for a Current/Future Hunter - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Dust Inhalation Dose (mg/m^3)	Reference Dose (mg/kg-d) [b] Oral	Reference Dose (mg/kg-d) [b] Dermal	RfC (mg/m^3) [b] Inhalation	Pathway-Specific Hazard Soil Ingestion	Pathway-Specific Hazard Dermal	Pathway-Specific Hazard Dust Inhalation	Chemical-Specific HQ
Arsenic	24.9	8.2E-07	7.4E-07	1.5E-10	3.0E-04	3.0E-04	1.5E-05	2.7E-03	2.5E-03	9.9E-06	0.0052
Uranium	40.5	2.2E-06	3.8E-07	2.4E-10	2.0E-04	2.0E-04	4.0E-05	1.1E-02	1.9E-03	6.0E-06	0.013
Vanadium	212	1.2E-05	2.0E-06	1.3E-09	5.0E-03	1.3E-04	1.0E-04	2.3E-03	1.5E-02	1.3E-05	0.018
										HI	0.04

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL	percent upper confidence limit
HI	hazard index
HQ	hazard quotient
mg/kg	milligrams per kilogram
mg/kd-d	milligrams per kilogram per day
mg/m^3	milligram per cubic meter
RfC	reference concentration
RME	reasonable maximum exposure

Table D-20
Tier II RME Henry Site Cancer Risk Calculation for a Recreational Camper/Hiker - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Inhalation Dose (ug/m^3)	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b] Oral	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b] Dermal	URF (ug/m^3)$^{-1}$ [b] Inhalation	Pathway-Specific Cancer Risk Soil Ingestion	Pathway-Specific Cancer Risk Dermal	Pathway-Specific Cancer Risk Inhalation	Chemical-Specific Risk
Arsenic	24.9	4.8E-07	3.2E-07	3.2E-08	1.5E+00	1.5E+00	4.3E-03	7.2E-07	4.8E-07	1.4E-10	1.2E-06
										ILCR	1E-06

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL	percent upper confidence limit
ILCR	incremental lifetime cancer risk
mg/kg	milligrams per kilogram
mg/kg-d	milligrams per kilogram per day
RME	reasonable maximum exposure
URF	unit risk factor
ug/m^3	microgram per cubic meter

Table D-21
Tier II RME Henry Site Noncancer Hazard Calculation for a Recreational Camper/Hiker - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Inhalation Dose (mg/m^3)	Reference Dose (mg/kg-d) [b] Oral	Reference Dose (mg/kg-d) [b] Dermal	RfC (mg/m^3) [b] Inhalation	Pathway-Specific Hazard Soil Ingestion	Pathway-Specific Hazard Dermal	Pathway-Specific Hazard Inhalation	Chemical-Specific HQ
Arsenic	24.9	1.1E-06	7.4E-07	7.4E-11	3.0E-04	3.0E-04	1.5E-05	3.7E-03	2.5E-03	4.9E-06	0.0062
Uranium	40.5	3.0E-06	3.8E-07	1.2E-10	2.0E-04	2.0E-04	4.0E-05	1.5E-02	1.9E-03	3.0E-06	0.017
Vanadium	212	1.6E-05	2.0E-06	6.3E-10	5.0E-03	1.3E-04	1.0E-04	3.2E-03	1.5E-02	6.3E-06	0.018
										HI	0.04

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL	percent upper confidence limit	mg/m^3	milligram per cubic meter
HI	hazard index	RfC	reference concentration
HQ	hazard quotient	RME	reasonable maximum exposure
mg/kg	milligrams per kilogram		
mg/kd-d	milligrams per kilogram per day		

Table D-22
Summary of Tier II RME Henry Site Human Health Risk Estimates - Upland Soil

	Concentration[a] (mg/kg)			Current/Future Native American		Hypothetical Future Resident		Current/Future Seasonal Rancher		Current/Future Recreational Hunter		Current/Future Recreational Camper/Hiker	
Analyte	**Maximum**	**95% UCL**	**EPC[b]**	**ILCR**	**HQ**	**ILCR**	**HQ**	**ILCR**	**HQ**	**ILCR**	**HQ**	**ILCR**	**HQ**
Arsenic	45.5	24.9	24.9	**4.7E-05**	0.24	**4.7E-05**	0.24	**8.0E-06**	0.052	8.0E-07	0.0052	1.2E-06	0.0062
Uranium	74.4	40.5	40.5	NA	0.65	NA	0.65	NA	0.12	NA	0.013	NA	0.017
Vanadium	584	212	212	NA	0.74	NA	0.74	NA	0.19	NA	0.018	NA	0.018
Cumulative ILCR/HQ:				**5E-05**	**2**	**5E-05**	**2**	**8E-06**	0.4	8E-07	0.04	1E-06	0.04
IDEQ Point of Departure:				10^{-5}	1								
USEPA Risk Range:				10^{-6} - 10^{-4}	1								

Notes:

[a] Maximum detected concentration and ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] The exposure point concentration (EPC) either the 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk

mg/kg - milligrams per kilogarm
NA - not applicable
USEPA - U. S. Environmental Protection Agency
RME - reasonable maximum exposure

Table D-23
Tier II CTE Henry Site Cancer Risk Calculation for a Current/Future Native American - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Dust Inhalation Dose (ug/m^3)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Dermal	URF $(ug/m^3)^{-1}$ [b] Inhalation	Pathway-Specific Cancer Risk Soil Ingestion	Pathway-Specific Cancer Risk Dermal	Pathway-Specific Cancer Risk Dust Inhalation	Chemical-Specific Risk
Arsenic	4.25	2.8E-07	3.8E-08	1.6E-09	1.5E+00	1.5E+00	4.3E-03	4.2E-07	5.7E-08	6.8E-12	4.8E-07
										ILCR	5E-07

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in riparian soil samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL	percent upper confidence limit
ILCR	incremental lifetime cancer risk
mg/kg	milligrams per kilogram
mg/kg-d	milligrams per kilogram per day
URF	unit risk factor
ug/m^3	microgram per cubic meter
CTE	central tendency exposure

Table D-24
Tier II CTE Henry Site Noncancer Hazard Calculation for a Current/Future Native American - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Dust Inhalation Dose (mg/m^3)	Reference Dose (mg/kg-d) [b]		RfC (mg/m^3) [b]	Pathway-Specific Hazard			Chemical-Specific HQ
					Oral	Dermal	Inhalation	Soil Ingestion	Dermal	Dust Inhalation	
Arsenic	4.25	2.4E-06	3.3E-07	1.4E-11	3.0E-04	3.0E-04	1.5E-05	8.1E-03	1.1E-03	9.2E-07	0.0092
Vanadium	165	1.6E-04	4.1E-06	5.3E-10	5.0E-03	1.3E-04	1.0E-04	3.1E-02	3.1E-02	5.3E-06	0.063
										HI	0.07

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in riparian soil samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL	percent upper confidence limit	mg/m^3	milligram per cubic meter
HI	hazard index	RfC	reference concentration
HQ	hazard quotient	CTE	central tendency exposure
mg/kg	milligrams per kilogram		
mg/kd-d	milligrams per kilogram per day		

Table D-25
Summary of Tier II CTE Henry Site Human Health Risk Estimates - Riparian Soil

Analyte	Concentration[a] (mg/kg)			Current/Future Native American		Recreational Fisher / Native American or Resident who Fishes [c]	
	Maximum	95% UCL	EPC[b]	ILCR	HQ	ILCR	HQ
Arsenic	4.99	4.25	4.25	4.8E-07	0.0092	NA	NA
Vanadium	773	165	165	NA	0.063	NA	NA
Cumulative ILCR/HQ:				5E-07	0.07	NA	NA
IDEQ Point of Departure:				10^{-5}	1		
USEPA Risk Range:				10^{-6} - 10^{-4}	1		

Notes:

[a] Maximum detected concentration and ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in riparian soil samples collected from Henry Site sampling locations.

[b] The exposure point concentration (EPC) is the lower of the maximum detected concentration or 95%, 97.5% or 99% UCL concentration.

[c] Riparian soil exposures associated with fishing were not evaluated in the Tier II risk assessment because risk and hazard estimates associated with this pathway in the Tier I risk assessment were not greater than the IDEQ point of departure or USEPA point of departure or risk range.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk

mg/kg - milligrams per kilogarm
NA - not applicable
USEPA - U. S. Environmental Protection Agency
CTE - central tendency exposure

Table D-26
Tier II RME Henry Site Cancer Risk Calculation for a Current/Future Native American - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Dust Inhalation Dose (ug/m^3)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b]		URF $(ug/m^3)^{-1}$ [b]	Pathway-Specific Cancer Risk			Chemical-Specific Risk
					Oral	Dermal	Inhalation	Soil Ingestion	Dermal	Dust Inhalation	
Arsenic	4.25	3.1E-06	2.2E-06	1.7E-08	1.5E+00	1.5E+00	4.3E-03	4.6E-06	3.4E-06	7.5E-11	**8.0E-06**
										ILCR	**8E-06**

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in riparian soil samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL	percent upper confidence limit	na	not available
ILCR	incremental lifetime cancer risk	URF	unit risk factor
mg/kg	milligrams per kilogram	ug/m^3	microgram per cubic meter
mg/kg-d	milligrams per kilogram per day	RME	reasonable maximum exposure

Table D-27
Tier II RME Henry Site Noncancer Hazard Calculation for a Current/Future Native American - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Dust Inhalation Dose (mg/m^3)	Reference Dose (mg/kg-d) [b] Oral	Reference Dose (mg/kg-d) [b] Dermal	RfC (mg/m^3) [b] Inhalation	Pathway-Specific Hazard Soil Ingestion	Pathway-Specific Hazard Dermal	Pathway-Specific Hazard Dust Inhalation	Chemical-Specific HQ
Arsenic	4.25	7.2E-06	5.2E-06	4.1E-11	3.0E-04	3.0E-04	1.5E-05	2.4E-02	1.7E-02	2.7E-06	0.041
Vanadium	165	4.6E-04	6.3E-05	1.6E-09	5.0E-03	1.3E-04	1.0E-04	9.3E-02	4.9E-01	1.6E-05	0.58
										HI	0.6

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in riparian soil samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL	percent upper confidence limit	mg/m^3	milligram per cubic meter
HI	hazard index	na	not available
HQ	hazard quotient	RfC	reference concentration
mg/kg	milligrams per kilogram	RME	reasonable maximum exposure
mg/kd-d	milligrams per kilogram per day		

Table D-28
Summary of Tier II RME Henry Site Human Health Risk Estimates - Riparian Soil

Analyte	Concentration[a] (mg/kg)			Current/Future Native American		Recreational Fisher / Native American or Resident who Fishes	
	Maximum	95% UCL	EPC[b]	ILCR	HQ	ILCR	HQ
Arsenic	4.99	4.25	4.25	**8.0E-06**	0.041	NA	NA
Vanadium	773	165	165	NA	0.58	NA	NA
Cumulative ILCR/HQ:				**8E-06**	0.6	NA	NA
IDEQ Point of Departure:				10^{-5}	1		
USEPA Risk Range:				10^{-6} - 10^{-4}	1		

Notes:

[a] Maximum detected concentration and ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in riparian soil samples collected from Henry Site sampling locations.

[b] The exposure point concentration (EPC) is the lower of the maximum detected concentration or 95%, 97.5% or 99% UCL concentration.

[c] Riparian soil exposures associated with fishing were not evaluated in the Tier II risk assessment because risk and hazard estimates associated with this pathway in the Tier I risk assessment were not greater than the IDEQ point of departure or USEPA point of departure or risk range.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
NA - not applicable
USEPA - U. S. Environmental Protection Agency
RME - reasonable maximum exposure

Table D-29
Tier II CTE Henry Site Cancer Risk Calculation for a Current/Future Native American - Surface Water

Analyte	Surface Water Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Dermal	Pathway-Specific Cancer Risk Ingestion	Pathway-Specific Cancer Risk Dermal	Chemical-Specific Risk
Arsenic	0.00928	3.9E-08	9.2E-09	1.5E+00	1.5E+00	5.8E-08	1.4E-08	7.2E-08
							ILCR	7E-08

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in surface water samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor

% UCL	percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	CTE	central tendency exposure
mg/L	milligrams per liter		

Table D-30
Tier II CTE Henry Site Noncancer Hazard Calculation for a Current/Future Native American - Surface Water

Analyte	Surface Water Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Reference Dose (mg/kg-d) [b] Dermal	Pathway-Specific Hazard Ingestion	Pathway-Specific Hazard Dermal	Chemical-Specific HQ
Arsenic	0.00928	3.4E-07	8.0E-08	3.0E-04	3.0E-04	1.1E-03	2.7E-04	0.0014
							HI	0.001

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in surface water samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose

% UCL	percent upper confidence limit	mg/kg	milligrams per kilogram
HI	hazard index	mg/kd-d	milligrams per kilogram per day
HQ	hazard quotient	CTE	central tendency exposure

Table D-31
Summary of Tier II CTE Henry Site Human Health Risk Estimates - Surface Water

	Concentration[a] (mg/L)			Current/Future Native American		Current/Future Recreational Fisher / Hypothetical Future Resident who Fishes [c]	
Analyte	**Maximum**	**95% UCL**	**EPC[b]**	**ILCR**	**HQ**	**ILCR**	**HQ**
Arsenic	0.0224	0.00928	0.00928	7.2E-08	0.0014	NA	NA
Cumulative ILCR/HQ:				7E-08	0.001	NA	NA
IDEQ Point of Departure:				10^{-5}	1		
USEPA Risk Range:				10^{-6} - 10^{-4}	1		

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in surface water samples collected from Henry Site sampling locations.

[b] The exposure point concentration (EPC) is either the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration.

[c] Surface water exposures associated with a current/future recreational fisher or hypothetical future resident who fishes were not evaluated in the Tier II risk assessment because risk and hazard estimates associated with this pathway in the Tier I risk assessment were not greater than the IDEQ point of departure or USEPA point of departure or risk range.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/L - milligrams per liter
NA - not applicable
USEPA - U. S. Environmental Protection Agency
CTE - central tendency exposure

Table D-32
Tier II RME Henry Site Cancer Risk Calculation for a Current/Future Native American - Surface Water

Analyte	Surface Water Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b]		Pathway-Specific Cancer Risk		Chemical-Specific Risk
				Oral	Dermal	Ingestion	Dermal	
Arsenic	0.00928	8.4E-07	3.1E-07	1.5E+00	1.5E+00	1.3E-06	4.7E-07	**1.7E-06**
							ILCR	**2E-06**

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in surface water samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor

% UCL	percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	RME	reasonable maximum exposure
mg/L	milligrams per liter		

Table D-33
Tier II RME Henry Site Noncancer Hazard Calculation for a Current/Future Native American - Surface Water

Analyte	Surface Water Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Reference Dose (mg/kg-d) [b] Dermal	Pathway-Specific Hazard Ingestion	Pathway-Specific Hazard Dermal	Chemical-Specific HQ
Arsenic	0.00928	2.0E-06	7.2E-07	3.0E-04	3.0E-04	6.5E-03	2.4E-03	0.0089
							HI	0.009

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in surface water samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose

% UCL	percent upper confidence limit	mg/kg	milligrams per kilogram
HI	hazard index	mg/kd-d	milligrams per kilogram per day
HQ	hazard quotient	RME	reasonable maximum exposure

Table D-34
Summary of Tier II RME Henry Site Human Health Risk Estimates - Surface Water

Analyte	Concentration[a] (mg/L)			Current/Future Native American		Current/Future Recreational Fisher / Hypothetical Future Resident who Fishes [c]	
	Maximum	95% UCL	EPC[b]	ILCR	HQ	ILCR	HQ
Arsenic	0.0224	0.00928	0.00928	**1.7E-06**	0.0089	NA	NA
Cumulative ILCR/HQ				**2E-06**	0.009	NA	NA
IDEQ Point of Departure:				10^{-5}	1		
USEPA Risk Range:				10^{-6} - 10^{-4}	1		

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in surface water samples collected from Henry Site sampling locations.

[b] The exposure point concentration (EPC) is either the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration.

[c] Surface water exposures associated with a current/future recreational fisher or hypothetical future resident who fishes were not evaluated in the Tier II risk assessment because risk and hazard estimates associated with this pathway in the Tier I risk assessment were not greater than the IDEQ point of

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/L - milligrams per liter
NA - not applicable
USEPA - U. S. Environmental Protection Agency
RME - reasonable maximum exposure

Table D-35
Tier II CTE Henry Site Cancer Risk Calculation for a Hypothetical Future Resident - Groundwater

Analyte	Groundwater Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b] Oral	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b] Dermal	Pathway-Specific Cancer Risk Ingestion	Pathway-Specific Cancer Risk Dermal	Chemical-Specific Risk
Arsenic	0.00227	3.7E-06	2.0E-08	1.5E+00	1.5E+00	5.5E-06	3.0E-08	**5.5E-06**
							ILCR	**6E-06**

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in groundwater samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor

CTE	central tendency exposure	mg/L	milligrams per liter
% UCL	percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	NA	not applicable

Table D-36
Tier II CTE Henry Site Noncancer Hazard Calculation for a Hypothetical Future Resident - Groundwater

Analyte	Groundwater Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b]		Pathway-Specific Hazard		Chemical-Specific HQ
				Oral	Dermal	Ingestion	Dermal	
Arsenic	0.00227	3.2E-05	1.7E-07	3.0E-04	3.0E-04	1.1E-01	5.8E-04	0.11
Cobalt	0.0100	1.4E-04	3.1E-07	3.0E-04	3.0E-04	4.7E-01	1.0E-03	0.47
Manganese	0.592	8.4E-03	4.6E-05	1.4E-01	5.6E-03	6.0E-02	8.1E-03	0.068
Selenium	0.0479	6.8E-04	3.7E-06	5.0E-03	1.5E-03	1.4E-01	2.5E-03	0.14
Thallium	0.000505	7.1E-06	3.9E-08	1.0E-05	1.0E-05	7.1E-01	3.9E-03	0.72
							HI	**2**

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in groundwater samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose

CTE	central tendency exposure	NA	not applicable
% UCL	percent upper confidence limit	mg/kg	milligrams per kilogram
HI	hazard index	mg/kd-d	milligrams per kilogram per day
HQ	hazard quotient		

Table D-37
Tier II CTE Henry Site Cancer Risk Calculation for a Current/Future Seasonal Rancher - Groundwater

Analyte	Groundwater Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b] Oral	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b] Dermal	Pathway-Specific Cancer Risk Ingestion	Pathway-Specific Cancer Risk Dermal	Chemical-Specific Risk
Arsenic	0.00227	6.7E-07	3.5E-09	1.5E+00	1.5E+00	1.0E-06	5.2E-09	1.0E-06
							ILCR	1E-06

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in groundwater samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor

CTE	central tendency exposure	NA	not applicable
% UCL	percent upper confidence limit	mg/L	milligrams per liter
ILCR	incremental lifetime cancer risk	mg/kg-d	milligrams per kilogram per day

Table D-38
Tier II CTE Henry Site Noncancer Hazard Calculation for a Current/Future Seasonal Rancher - Groundwater

Analyte	Groundwater Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b]		Pathway-Specific Hazard		Chemical-Specific HQ
				Oral	Dermal	Ingestion	Dermal	
Arsenic	0.00227	1.2E-06	3.8E-08	3.0E-04	3.0E-04	3.8E-03	1.3E-04	0.0040
Cobalt	0.0100	5.1E-06	6.7E-08	3.0E-04	3.0E-04	1.7E-02	2.2E-04	0.017
Manganese	0.592	3.0E-04	9.9E-06	1.4E-01	5.6E-03	2.1E-03	1.8E-03	0.0039
Selenium	0.0479	2.4E-05	8.0E-07	5.0E-03	1.5E-03	4.9E-03	5.3E-04	0.0054
Thallium	0.000505	2.6E-07	8.4E-09	1.0E-05	1.0E-05	2.6E-02	8.4E-04	0.026
							HI	0.06

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in groundwater samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose

CTE	central tendency exposure	NA	not applicable
% UCL	percent upper confidence limit	mg/kg	milligrams per kilogram
HI	hazard index	mg/kd-d	milligrams per kilogram per day
HQ	hazard quotient		

Table D-39
Summary of Tier II CTE Henry Site Human Health Risk Estimates - Groundwater

Analyte	Concentration[a] (mg/L)			Hypothetical Future Resident		Current/Future Seasonal Rancher	
	Maximum	95% UCL	EPC[b]	ILCR	HQ	ILCR	HQ
Arsenic	0.00430	0.00227	0.00227	**5.5E-06**	0.11	1.0E-06	0.0040
Cobalt	0.0100	NC	0.0100	NA	0.47	NA	0.017
Manganese	3.39	0.592	0.592	NA	0.068	NA	0.0039
Selenium	0.219	0.0479	0.0479	NA	0.14	NA	0.0054
Thallium	0.000900	0.000505	0.000505	NA	0.72	NA	0.026
Cumulative ILCR/HQ				**6E-06**	**2**	1E-06	0.06
IDEQ Point of Departure:				10^{-5}	1	10^{-5}	1
USEPA Risk Range:				10^{-6} - 10^{-4}	1	10^{-6} - 10^{-4}	1

Notes:

a Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in groundwater samples collected from Henry Site sampling locations.

b The exposure point concentration (EPC) is either the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/L - milligrams per liter

NA - not applicable
NC - not calculated
USEPA - U. S. Environmental Protection Agency
CTE - central tendency exposure

Table D-40
Tier II RME Henry Site Cancer Risk Calculation for a Hypothetical Future Resident - Groundwater

Analyte	Groundwater Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b]		Pathway-Specific Cancer Risk		Chemical-Specific Risk
				Oral	Dermal	Ingestion	Dermal	
Arsenic	0.00227	4.0E-05	2.3E-07	1.5E+00	1.5E+00	6.0E-05	3.5E-07	**6.0E-05**
							ILCR	**6E-05**

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in groundwater samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor

% UCL	percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	NA	not applicable
mg/L	milligrams per liter	RME	reasonable maximum exposure

Table D-41
Tier II RME Henry Site Noncancer Hazard Calculation for a Hypothetical Future Resident - Groundwater

Analyte	Groundwater Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b]		Pathway-Specific Hazard		Chemical-Specific HQ
				Oral	Dermal	Ingestion	Dermal	
Arsenic	0.00227	9.3E-05	5.4E-07	3.0E-04	3.0E-04	3.1E-01	1.8E-03	0.31
Cobalt	0.0100	4.1E-04	9.5E-07	3.0E-04	3.0E-04	1.4E+00	3.2E-03	**1.4**
Manganese	0.592	2.4E-02	1.4E-04	1.4E-01	5.6E-03	1.7E-01	2.5E-02	0.20
Selenium	0.0479	2.0E-03	1.1E-05	5.0E-03	1.5E-03	3.9E-01	7.6E-03	0.40
Thallium	0.000505	2.1E-05	1.2E-07	1.0E-05	1.0E-05	2.1E+00	1.2E-02	**2.1**
							HI	**4**

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in groundwater samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	NA	not applicable
HQ	hazard quotient	RME	reasonable maximum exposure
mg/kg	milligrams per kilogram		

Table D-42
Tier II RME Henry Site Cancer Risk Calculation for a Current/Future Seasonal Rancher - Groundwater

Analyte	Groundwater Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b]		Pathway-Specific Cancer Risk		Chemical-Specific Risk
				Oral	Dermal	Ingestion	Dermal	
Arsenic	0.00227	7.3E-06	5.0E-08	1.5E+00	1.5E+00	1.1E-05	7.5E-08	**1.1E-05**
							ILCR	**1E-05**

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in groundwater samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor

% UCL	percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	NA	not applicable
mg/L	milligrams per liter	RME	reasonable maximum exposure

Table D-43
Tier II RME Henry Site Noncancer Hazard Calculation for a Current/Future Seasonal Rancher - Groundwater

Analyte	Groundwater Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Reference Dose (mg/kg-d)[b] Oral	Reference Dose (mg/kg-d)[b] Dermal	Pathway-Specific Hazard Ingestion	Pathway-Specific Hazard Dermal	Chemical-Specific HQ
Arsenic	0.00227	8.9E-07	1.5E-07	3.0E-04	3.0E-04	3.0E-03	4.9E-04	0.0034
Cobalt	0.0100	3.9E-06	2.6E-07	3.0E-04	3.0E-04	1.3E-02	8.6E-04	0.014
Manganese	0.592	2.3E-04	3.8E-05	1.4E-01	5.6E-03	1.7E-03	6.8E-03	0.0085
Selenium	0.0479	1.9E-05	3.1E-06	5.0E-03	1.5E-03	3.7E-03	2.1E-03	0.0058
Thallium	0.000505	2.0E-07	3.3E-08	1.0E-05	1.0E-05	2.0E-02	3.3E-03	0.023
							HI	0.05

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in groundwater samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	NA	not applicable
HQ	hazard quotient	RME	reasonable maximum exposure
mg/kg	milligrams per kilogram		

Table D-44
Summary of Tier II RME Henry Site Human Health Risk Estimates - Groundwater

Analyte	Concentration[a] (mg/L)			Hypothetical Future Resident		Current/Future Seasonal Rancher	
	Maximum	95% UCL	EPC[b]	ILCR	HQ	ILCR	HQ
Arsenic	0.00430	0.00227	0.00227	**6.0E-05**	0.31	**1.1E-05**	0.0034
Cobalt	0.0100	NC	0.0100	NA	**1.4**	NA	0.014
Manganese	3.39	0.592	0.592	NA	0.20	NA	0.0085
Selenium	0.219	0.0479	0.0479	NA	0.40	NA	0.0058
Thallium	0.000900	0.000505	0.000505	NA	**2.1**	NA	0.023
Cumulative ILCR/HQ				**6E-05**	**4**	**1E-05**	0.05
IDEQ Point of Departure:				10^{-5}	1	10^{-5}	1
USEPA Risk Range:				10^{-6} - 10^{-4}	1	10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in groundwater samples collected from Henry Site sampling locations.

[b] The exposure point concentration (EPC) is the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk

NA - not applicable
NC - not calculated
USEPA - U. S. Environmental Protection Agency

Table D-45
Tier II CTE Henry Site Cancer Risk Calculation for a Current/Future Native American - Culturally Significant Plants - Upland Soi

Analyte	Upland Soil Concentration[a] (mg/kg)	Modeled Culturally Significant Plant Concentration from Soil (mg/kg)	Measured Culturally Significant Plants Concentration (mg/kg)	Modeled Plant Ingestion Dose (mg/kg-d)	Measured Plant Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Pathway-Specific Cancer Risk: Modeled Plant Ingestion	Pathway-Specific Cancer Risk: Measured Plant Ingestion	Chemical-Specific Risk [c]
Arsenic	24.9	0.585	0.0459	6.7E-05	5.3E-06	1.5E+00	1.0E-04	7.9E-06	**7.9E-06**
								ILCR	**8E-06**

Notes:

[a] The ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

[c] Where available, measured plant concentrations were used preferentially over modeled plant concentrations to calculate risk.

% UCL	percent upper confidence limit
ILCR	incremental lifetime cancer risk
mg/kg	milligrams per kilogram
mg/kg-d	milligrams per kilogram per day
CTE	central tendency exposure

Table D-46
Tier II CTE Henry Site Noncancer Hazard Calculation for a Current/Future Native American - Culturally Significant Plants - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Modeled Culturally Significant Plant Concentration from Soil (mg/kg)	Measured Culturally Significant Plants Concentration (mg/kg)	Modeled Plant Ingestion Dose (mg/kg-d)	Measured Plant Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Pathway-Specific Hazard Modeled Plant Ingestion	Pathway-Specific Hazard Measured Plant Ingestion	Chemical-Specific HQ [c]
Antimony	4.81	0.305	0.170	3.1E-04	1.7E-04	4.0E-04	0.77	0.4	0.43
Arsenic	24.9	0.585	0.0459	5.9E-04	4.6E-05	3.0E-04	2.0	0.15	0.15
Cadmium	32.5	4.51	1.72	4.5E-03	1.7E-03	1.0E-03	4.5	1.7	**1.7**
Cobalt	7.74	0.143	0.171	1.4E-04	1.7E-04	3.0E-04	0.48	0.57	0.57
Selenium	46.4	0.918	1.27	9.2E-04	1.3E-03	5.0E-03	0.18	0.26	0.26
Thallium	1.31	0.0189	0.00335	1.9E-05	3.4E-06	1.0E-05	1.9	0.34	0.34
								HI	**3**

Notes:

[a] The ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

[c] Where available, measured plant concentrations were used preferentially over modeled plant concentrations to calculate an HQ.

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	CTE	central tendency exposure
HQ	hazard quotient		
mg/kg	milligrams per kilogram		

Table D-47
Summary of Tier II CTE Henry Site Human Health Risk Estimates - Culturally Significant Plants - Upland Soil

	Upland Soil Concentration[a] (mg/kg)			Modeled Culturally Significant Plants Concentration (mg/kg)	Measured Culturally Significant Plants Concentration (mg/kg)	Current/Future Native American	
Analyte	**Maximum**	**95% UCL**	**EPC[b]**	**EPC[c]**	**EPC[d]**	**ILCR**	**HQ**
Antimony	9.15	4.81	4.81	0.305	0.170	NA	0.43
Arsenic	45.5	24.9	24.9	0.585	0.0459	**7.9E-06**	0.15
Cadmium	59.5	32.5	32.5	4.51	1.72	NA	**1.7**
Cobalt	11.9	7.74	7.74	0.143	0.171	NA	0.57
Selenium	318	46.4	46.4	0.918	1.27	NA	0.26
Thallium	2.31	1.31	1.31	0.0189	0.00335	NA	0.34
					Cumulative ILCR/HQ:	**8E-06**	**3**
					IDEQ Point of Departure:	10^{-5}	1
					USEPA Risk Range:	10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration and ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] The ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration measured in upland soil samples collected from Henry Site sampling locations.

[c] The culturally significant plants EPC was modeled from the upland soil EPC using soil-to-plant uptake factors.

[d] The ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration measured in culturally significant plants samples in wet weight. The dry weight culturally significant plants data were converted to wet weight using an average moisture content of 66 percent.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
NA - not applicable
USEPA - U. S. Environmental Protection Agency
CTE - central tendency exposure

Table D-48
Tier II CTE Henry Site Cancer Risk Calculation for a Current/Future Native American - Culturally Significant Plants - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg)	Modeled Culturally Significant Plant Concentration from Soil (mg/kg)	Measured Riparian Plant Concentration (mg/kg)	Modeled Plant Ingestion Dose (mg/kg-d)	Measured Plant Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Pathway-Specific Cancer Risk: Modeled Plant Ingestion	Pathway-Specific Cancer Risk: Measured Plant Ingestion	Chemical-Specific Risk [c]
Arsenic	4.25	0.100	na	1.2E-05	na	1.5E+00	1.7E-05	na	**1.7E-05**
								ILCR	**2E-05**

Notes:

[a] The exposure point concentration (EPC) is the 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

[c] Where available, measured plant concentrations were used preferentially over modeled plant concentrations to calculate risk.

% UCL	percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	na	not available
mg/kg	milligrams per kilogram	CTE	central tendency exposure

Table D-49
Tier II CTE Henry Site Noncancer Hazard Calculation for a Current/Future Native American - Culturally Significant Plants - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg)	Modeled Culturally Significant Plant Concentration from Soil (mg/kg)	Measured Riparian Plant Concentration (mg/kg)	Modeled Plant Ingestion Dose (mg/kg-d)	Measured Plant Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Pathway-Specific Hazard: Modeled Plant Ingestion	Pathway-Specific Hazard: Measured Plant Ingestion	Chemical-Specific HQ [c]
Antimony	6.17	0.392	na	3.9E-04	na	4.0E-04	9.9E-01	na	0.99
Arsenic	4.25	0.100	na	1.0E-04	na	3.0E-04	3.4E-01	na	0.34
Cadmium	7.38	1.02	0.235	1.0E-03	2.4E-04	1.0E-03	1.0E+00	2.4E-01	0.24
Cobalt	7.98	0.148	na	1.5E-04	na	3.0E-04	5.0E-01	na	0.50
Manganese	901	68.5	na	6.9E-02	na	1.4E-01	4.9E-01	na	0.49
Nickel	70.4	2.01	na	2.0E-03	na	2.0E-02	1.0E-01	na	0.10
Selenium	14.9	0.295	2.94	3.0E-04	3.0E-03	5.0E-03	5.9E-02	5.9E-01	0.59
Thallium	0.200	0.00290	na	2.9E-06	na	1.0E-05	2.9E-01	na	0.29
Vanadium	165	2.46	na	2.5E-03	na	5.0E-03	4.9E-01	na	0.49
								HI	**4**

Notes:

[a] The exposure point concentration (EPC) is the 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

[c] Where available, measured plant concentrations were used preferentially over modeled plant concentrations to calculate an HQ.

HI	hazard index	mg/kd-d	milligrams per kilogram per day
HQ	hazard quotient	na	not available
mg/kg	milligrams per kilogram	CTE	central tendency exposure

Table D-50
Summary of Tier II CTE Henry Site Human Health Risk Estimates - Culturally Significant Plants - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg) Maximum	95% UCL	EPC[b]	Modeled Culturally Significant Plants Concentration (mg/kg) EPC[c]	Measured Riparian Plants Concentration (mg/kg) EPC[d]	Current/Future Native American ILCR	HQ
Antimony	7.00	6.17	6.17	0.392	na	NA	0.99
Arsenic	4.99	4.25	4.25	0.100	na	**1.7E-05**	0.34
Cadmium	67.3	7.38	7.38	1.02	0.235	NA	0.24
Cobalt	8.73	7.98	7.98	0.148	na	NA	0.50
Manganese	1,080	901	901	68.5	na	NA	0.49
Nickel	251	70.4	70.4	2.01	na	NA	0.10
Selenium	45.0	14.9	14.9	0.295	2.94	NA	0.59
Thallium	0.223	0.200	0.200	0.00290	na	NA	0.29
Vanadium	773	165	165	2.46	na	NA	0.49
					Cumulative ILCR/HQ:	**2E-05**	**4**
					IDEQ Point of Departure:	10^{-5}	1
					USEPA Risk Range:	10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration and ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in riparian soil samples collected from Henry Site sampling locations.

[b] The exposure point concentration (EPC) is the 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration.

[c] The culturally significant plants EPC was modeled from the riparian soil EPC using soil-to-plant uptake factors.

[d] The ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured or the maximum detected concentration in culturally significant plants samples in wet weight. The dry weight culturally significant plants data were converted to wet weight using an average moisture content of 66 percent.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
NA - not applicable
na - not available
USEPA - U. S. Environmental Protection Agency
CTE - central tendency exposure

Table D-51
Tier II RME Henry Site Cancer Risk Calculation for a Current/Future Native American - Culturally Significant Plants - Upland Soi

Analyte	Upland Soil Concentration[a] (mg/kg)	Modeled Culturally Significant Plant Concentration from Soil (mg/kg)	Measured Culturally Significant Plants Concentration (mg/kg)	Modeled Plant Ingestion Dose (mg/kg-d)	Measured Plant Ingestion Dose (mg/kg-d)	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b] Oral	Pathway-Specific Cancer Risk: Modeled Plant Ingestion	Pathway-Specific Cancer Risk: Measured Plant Ingestion	Chemical-Specific Risk [c]
Arsenic	24.9	0.585	0.046	1.3E-03	1.0E-04	1.5E+00	2.0E-03	1.5E-04	**1.5E-04**
								ILCR	**2E-04**

Notes:

[a] The ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

[c] Where available, measured plant concentrations were used preferentially over modeled plant concentrations to calculate risk.

% UCL	percent upper confidence limit
ILCR	incremental lifetime cancer risk
mg/kg	milligrams per kilogram
mg/kg-d	milligrams per kilogram per day
RME	reasonable maximum exposure

Table D-52
Tier II RME Henry Site Noncancer Hazard Calculation for a Current/Future Native American - Culturally Significant Plants - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Modeled Culturally Significant Plant Concentration from Soil (mg/kg)	Measured Culturally Significant Plants Concentration (mg/kg)	Modeled Plant Ingestion Dose (mg/kg-d)	Measured Plant Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Pathway-Specific Hazard Modeled Plant Ingestion	Pathway-Specific Hazard Measured Plant Ingestion	Chemical-Specific HQ [c]
Antimony	4.81	0.305	0.170	1.6E-03	8.8E-04	4.0E-04	4.0	2.2	**2.2**
Arsenic	24.9	0.585	0.0459	3.0E-03	2.4E-04	3.0E-04	10	0.80	0.80
Cadmium	32.5	4.51	1.72	2.3E-02	9.0E-03	1.0E-03	23	9.0	**9.0**
Cobalt	7.74	0.143	0.171	7.5E-04	8.9E-04	3.0E-04	2.5	3.0	**3.0**
Selenium	46.4	0.918	1.27	4.8E-03	6.6E-03	5.0E-03	1.0	1.3	**1.3**
Thallium	1.31	0.0189	0.00335	9.9E-05	1.7E-05	1.0E-05	9.9	1.7	**1.7**
								HI	**18**

Notes:

[a] The ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

[c] Where available, measured plant concentrations were used preferentially over modeled plant concentrations to calculate an HQ.

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	RME	reasonable maximum exposure
HQ	hazard quotient		
mg/kg	milligrams per kilogram		

Table D-53
Summary of Tier II RME Henry Site Human Health Risk Estimates - Culturally Significant Plants - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)			Modeled Culturally Significant Plants Concentration (mg/kg)	Measured Culturally Significant Plants Concentration (mg/kg)	Current/Future Native American	
	Maximum	95% UCL	EPC[b]	EPC[c]	EPC[d]	ILCR	HQ
Antimony	9.15	4.81	4.81	0.305	0.170	NA	**2.2**
Arsenic	45.5	24.9	24.9	0.585	0.0459	**1.5E-04**	0.80
Cadmium	59.5	32.5	32.5	4.51	1.72	NA	**9.0**
Cobalt	11.9	7.74	7.74	0.1434	0.171	NA	**3.0**
Selenium	318	46.4	46.4	0.918	1.27	NA	**1.3**
Thallium	2.31	1.31	1.31	0.01895	0.00335	NA	**1.7**
					Cumulative ILCR/HQ:	**2E-04**	**18**
					IDEQ Point of Departure:	10^{-5}	1
					USEPA Risk Range:	10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration and ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from Henry Site sampling locations.

[b] The ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration measured in upland soil samples collected from Henry Site sampling locations.

[c] The culturally significant plants EPC was modeled from the upland soil EPC using soil-to-plant uptake factors.

[d] The ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration measured in culturally significant plants samples in wet weight. The dry weight culturally significant plants data were converted to wet weight using an average moisture content of 66 percent.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
NA - not applicable
USEPA - U. S. Environmental Protection Agency
RME - reasonable maximum exposure

Table D-54
Tier II RME Henry Site Cancer Risk Calculation for a Current/Future Native American - Culturally Significant Plants - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg)	Modeled Culturally Significant Plant Concentration from Soil (mg/kg)	Measured Riparian Plant Concentration (mg/kg)	Modeled Plant Ingestion Dose (mg/kg-d)	Measured Plant Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Pathway-Specific Cancer Risk: Modeled Plant Ingestion	Pathway-Specific Cancer Risk: Measured Plant Ingestion	Chemical-Specific Risk [c]
Arsenic	4.25	0.100	na	2.2E-04	na	1.5E+00	3.3E-04	na	**3.3E-04**
								ILCR	**3E-04**

Notes:

[a] The exposure point concentration (EPC) is the 95%, 97.5% or 99% UCL on the mean concentration or maximum detected concentration.
[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.
[c] Where available, measured plant concentrations were used preferentially over modeled plant concentrations to calculate risk.

% UCL	percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	na	not available
mg/kg	milligrams per kilogram	RME	reasonable maximum exposure

Table D-55
Tier II RME Henry Site Noncancer Hazard Calculation for a Current/Future Native American - Culturally Significant Plants - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg)	Modeled Culturally Significant Plant Concentration from Soil (mg/kg)	Measured Riparian Plant Concentration (mg/kg)	Modeled Plant Ingestion Dose (mg/kg-d)	Measured Plant Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Pathway-Specific Hazard Modeled Plant Ingestion	Pathway-Specific Hazard Measured Plant Ingestion	Chemical-Specific HQ [c]
Antimony	6.17	0.392	na	2.0E-03	na	4.0E-04	5.1E+00	na	**5.1**
Arsenic	4.25	0.100	na	5.2E-04	na	3.0E-04	1.7E+00	na	**1.7**
Cadmium	7.38	1.02	0.235	5.3E-03	1.2E-03	1.0E-03	5.3E+00	1.2E+00	**1.2**
Cobalt	7.98	0.148	na	7.7E-04	na	3.0E-04	2.6E+00	na	**2.6**
Manganese	901	68.5	na	3.6E-01	na	1.4E-01	2.5E+00	na	**2.5**
Nickel	70.4	2.01	na	1.0E-02	na	2.0E-02	5.2E-01	na	0.52
Selenium	14.9	0.295	2.94	1.5E-03	1.5E-02	5.0E-03	3.1E-01	3.1E+00	**3.1**
Thallium	0.200	0.00290	na	1.5E-05	na	1.0E-05	1.5E+00	na	**1.5**
Vanadium	165	2.46	na	1.3E-02	na	5.0E-03	2.6E+00	na	**2.6**
								HI	**21**

Notes:

[a] The exposure point concentration (EPC) is the 95%, 97.5% or 99% UCL on the mean concentration or maximum detected concentration.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

[c] Where available, measured plant concentrations were used preferentially over modeled plant concentrations to calculate an HQ.

HI	hazard index	mg/kd-d	milligrams per kilogram per day
HQ	hazard quotient	na	not available
mg/kg	milligrams per kilogram	RME	reasonable maximum exposure

Table D-56
Summary of Tier II RME Henry Site Human Health Risk Estimates - Culturally Significant Plants - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg)			Modeled Culturally Significant Plants Concentration (mg/kg)	Measured Riparian Plants Concentration (mg/kg)	Current/Future Native American	
	Maximum	95% UCL	EPC[b]	EPC[c]	EPC[d]	ILCR	HQ
Antimony	7.00	6.17	6.17	0.392	na	NA	**5.1**
Arsenic	4.99	4.25	4.25	0.100	na	**3.3E-04**	**1.7**
Cadmium	67.3	7.38	7.38	1.02	0.235	NA	**1.2**
Cobalt	8.73	7.98	7.98	0.148	na	NA	**2.6**
Manganese	1,080	901	901	68.5	na	NA	**2.5**
Nickel	251	70.4	70.4	2.01	na	NA	0.52
Selenium	45.0	14.9	14.9	0.295	2.94	NA	**3.1**
Thallium	0.223	0.200	0.200	0.00290	na	NA	**1.5**
Vanadium	773	165	165	2.46	na	NA	**2.6**
					Cumulative ILCR/HQ:	**3E-04**	**21**
					IDEQ Point of Departure:	10^{-5}	1
					USEPA Risk Range:	10^{-6} - 10^{-4}	1

Notes:

a Maximum detected concentration and ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in riparian soil samples collected from Henry Site sampling locations.

b The exposure point concentration (EPC) is the 95%, 97.5% or 99% UCL on the mean concentration or maximum detected concentration.

c The culturally significant plants EPC was modeled from the riparian soil EPC using soil-to-plant uptake factors.

d The ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration measured in culturally significant plants samples in wet weight. The dry weight culturally significant plants data were converted to wet weight using an average moisture

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk

mg/kg - milligrams per kilogarm
NA - not applicable
na - not available
USEPA - U. S. Environmental Protection Agency
RME - reasonable maximum exposure

Table D-57
Tier II CTE Henry Site Cancer Risk Calculation for a Hypothetical Future Resident - Fruits and Vegetables - Upland Soil and Groundwater

Analyte	Upland Soil Concentration[a] (mg/kg)	Groundwater Concentration[a] (mg/L)	Modeled Fruits and Vegetables Concentration from Soil (mg/kg)	Modeled Fruits and Vegetables Concentration from Groundwater (mg/kg)	Measured Non-Culturally Significant Plants Concentration (mg/kg)	Total Fruits and Vegetables Concentration [b] (mg/kg)	Plant Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [c] Oral	Chemical-Specific Risk
Arsenic	24.9	0.00227	0.585	0.0102	0.575	0.585	6.7E-05	1.5E+00	**1.0E-04**
								ILCR	**1E-04**

Notes:

[a] The ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration measured in upland soil and groundwater samples collected from Henry Site sampling locations.

[b] For an analyte that is only a constituent of potential concern (COPC) in soil, measured non-culturally significant plant concentration, when available, was used to represent the fruits and vegetables concentration. If an analyte is a COPC in groundwater, the total fruits and vegetables concentration is equal to the modeled concentration from groundwater plus either the measured non-culturally significant plant concentration when available, or the modeled concentration from soil.

[c] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	mg/L	milligrams per liter
mg/kg	milligrams per kilogram	CTE	central tendency exposure

Table D-58
Tier II CTE Henry Site Noncancer Hazard Calculation for a Hypothetical Future Resident - Fruits and Vegetables - Upland Soil and Groundwater

Analyte	Upland Soil Concentration[a] (mg/kg)	Groundwater Concentration[a] (mg/L)	Modeled Fruits and Vegetables Concentration from Soil (mg/kg)	Modeled Fruits and Vegetables Concentration from Groundwater (mg/kg)	Measured Non-Culturally Significant Plants Concentration (mg/kg)	Total Fruits and Vegetables Concentration [b] (mg/kg)	Plant Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [c] Oral	Chemical-Specific HQ
Antimony	4.81	NA	0.305	NA	0.176	0.176	4.7E-05	4.0E-04	0.12
Arsenic	24.9	0.00227	0.585	0.0102	0.575	0.585	1.6E-04	3.0E-04	0.52
Cadmium	32.5	NA	4.51	NA	0.535	0.535	1.4E-04	1.0E-03	0.14
Cobalt	7.74	0.0100	0.143	0.0430	0.0428	0.0859	2.3E-05	3.0E-04	0.077
Manganese	658	0.592	50.0	3.77	9.69	13.5	3.6E-03	1.4E-01	0.026
Molybdenum	NA	0.0373	NA	0.237	7.08	7.31	2.0E-03	5.0E-03	0.39
Nickel	212	NA	6.04	NA	1.59	1.59	4.3E-04	2.0E-02	0.021
Selenium	46.4	0.0479	0.918	0.208	5.74	5.94	1.6E-03	5.0E-03	0.32
Thallium	1.31	0.000505	0.0189	0.00210	0.0850	0.0871	2.3E-05	1.0E-05	**2.3**
Uranium	40.5	NA	0.634	NA	0.0490	0.0490	1.3E-05	2.0E-04	0.066
Vanadium	212	NA	3.16	NA	0.421	0.421	1.1E-04	5.0E-03	0.023
								HI	**4**

Notes:

[a] The ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration measured in upland soil and groundwater samples collected from Henry Site sampling locations.

[b] For an analyte that is only a constituent of potential concern (COPC) in soil, measured non-culturally significant plant concentration, when available, was used to represent the fruits and vegetables concentration. If an analyte is a COPC in groundwater, the total fruits and vegetables concentration is equal to the modeled concentration from groundwater plus either the measured non-culturally significant plant concentration when available, or the modeled concentration from soil.

[c] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kg	milligrams per kilogram	NA	not applicable
HI	hazard index	mg/kd-d	milligrams per kilogram per day	CTE	central tendency exposure
HQ	hazard quotient	mg/L	milligrams per liter		

Table D-59
Summary of Tier II CTE Henry Site Human Health Risk Estimates - Fruits and Vegetables - Upland Soil and Groundwater

	Upland Soil Concentration[a] (mg/kg)			Groundwater Concentration[a] (mg/L)			Modeled Total Fruits and Vegetables Concentration (mg/kg)	Measured Non-Culturally Significant Plants Concentration (mg/kg)	Hypothetical Future Resident	
Analyte	**Maximum**	**95% UCL**	**EPC[b]**	**Maximum**	**95% UCL**	**EPC[c]**	**EPC[d]**	**EPC[e]**	**ILCR**	**HQ**
Antimony	9.15	4.81	4.81	NA	NA	NA	0.176	0.176	NA	0.12
Arsenic	45.5	24.9	24.9	0.00430	0.00227	0.00227	0.585	0.575	**1.0E-04**	0.52
Cadmium	59.5	32.5	32.5	NA	NA	NA	0.535	0.535	NA	0.14
Cobalt	11.9	7.74	7.74	0.0100	NC	0.0100	0.0859	0.0428	NA	0.077
Manganese	2,040	658	658	3.39	0.592	0.592	13.5	9.69	NA	0.026
Molybdenum	NA	NA	NA	0.110	0.0373	0.0373	7.31	7.08	NA	0.39
Nickel	425	212	212	NA	NA	NA	1.59	1.59	NA	0.021
Selenium	318	46.4	46.4	0.219	0.0479	0.0479	5.94	5.74	NA	0.32
Thallium	2.31	1.31	1.31	0.000900	0.000505	0.000505	0.0871	0.0850	NA	**2.3**
Uranium	74.4	40.5	40.5	NA	NA	NA	0.0490	0.0490	NA	0.066
Vanadium	584	212	212	NA	NA	NA	0.421	0.421	NA	0.023
								Cumulative ILCR/HQ:	**1E-04**	**4**
								IDEQ Point of Departure:	10^{-5}	1
								USEPA Risk Range:	10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration and ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil and groundwater samples collected from Henry Site sampling locations.

[b] The soil EPC used to model fruits and vegetables concentration is the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration.

[c] The groundwater EPC used to model fruits and vegetables concentration is the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration.

[d] The fruits and vegetables EPC was modeled from the groundwater EPC and the measured plant EPC, where available, or the soil EPC using plant uptake factors as described in Table D-57 and Table D-58.

[e] The ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration measured in non-culturally significant plant samples in wet weight. The dry weight non-culturally significant data were converted to wet weight using an average moisture content of 66 percent.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
mg/L - milligrams per liter
NA - not applicable
NC - not calculated
USEPA - U. S. Environmental Protection Agency
CTE - central tendency exposure

Table D-60
Tier II RME Henry Site Cancer Risk Calculation for a Hypothetical Future Resident - Fruits and Vegetables - Upland Soil and Groundwater

Analyte	Upland Soil Concentration[a] (mg/kg)	Groundwater Concentration[a] (mg/L)	Modeled Fruits and Vegetables Concentration from Soil (mg/kg)	Modeled Fruits and Vegetables Concentration from Groundwater (mg/kg)	Measured Non-Culturally Significant Plants Concentration (mg/kg)	Total Fruits and Vegetables Concentration [b] (mg/kg)	Plant Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [c] Oral	Chemical-Specific Risk
Arsenic	24.9	0.00227	0.585	0.0102	0.575	0.585	1.3E-03	1.5E+00	**2.0E-03**
								ILCR	**2E-03**

Notes:

[a] The ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration measured in upland soil and groundwater samples collected from Henry Site sampling locations.

[b] For an analyte that is only a constituent of potential concern (COPC) in soil, measured non-culturally significant plant concentration, when available, was used to represent the fruits and vegetables concentration. If an analyte is a COPC in groundwater, the total fruits and vegetables concentration is equal to the modeled concentration from groundwater plus either the measured non-culturally significant plant concentration when available, or the modeled concentration from soil.

[c] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	mg/L	milligrams per liter
mg/kg	milligrams per kilogram	RME	reasonable maximum exposure

Table D-61
Tier II RME Henry Site Noncancer Hazard Calculation for a Hypothetical Future Resident - Fruits and Vegetables - Upland Soil and Groundwater

Analyte	Upland Soil Concentration[a] (mg/kg)	Groundwater Concentration[a] (mg/L)	Modeled Fruits and Vegetables Concentration from Soil (mg/kg)	Modeled Fruits and Vegetables Concentration from Groundwater (mg/kg)	Measured Non-Culturally Significant Plants Concentration (mg/kg)	Total Fruits and Vegetables Concentration [b] (mg/kg)	Plant Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [c] Oral	Chemical-Specific HQ
Antimony	4.81	NA	0.305	NA	0.176	0.176	9.2E-04	4.0E-04	**2.3**
Arsenic	24.9	0.00227	0.585	0.0102	0.575	0.585	3.0E-03	3.0E-04	**10**
Cadmium	32.5	NA	4.51	NA	0.535	0.535	2.8E-03	1.0E-03	**2.8**
Cobalt	7.74	0.0100	0.143	0.0430	0.0428	0.0859	4.5E-04	3.0E-04	**1.5**
Manganese	658	0.592	50.0	3.77	9.69	13.5	7.0E-02	1.4E-01	0.50
Molybdenum	NA	0.0373	NA	0.237	7.08	7.31	3.8E-02	5.0E-03	**7.6**
Nickel	212	NA	6.04	NA	1.59	1.59	8.3E-03	2.0E-02	0.41
Selenium	46.4	0.0479	0.918	0.208	5.74	5.94	3.1E-02	5.0E-03	**6.2**
Thallium	1.31	0.000505	0.0189	0.00210	0.0850	0.0871	4.5E-04	1.0E-05	**45**
Uranium	40.5	NA	0.634	NA	0.0490	0.0490	2.5E-04	2.0E-04	**1.3**
Vanadium	212	NA	3.16	NA	0.421	0.421	2.2E-03	5.0E-03	0.44
								HI	**78**

Notes:

[a] The ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration measured in upland soil and groundwater samples collected from Henry Site sampling locations.

[b] For an analyte that is only a constituent of potential concern (COPC) in soil, measured non-culturally significant plant concentration, when available, was used to represent the fruits and vegetables concentration. If an analyte is a COPC in groundwater, the total fruits and vegetables concentration is equal to the modeled concentration from groundwater plus either the measured non-culturally significant plant concentration when available, or the modeled concentration from soil.

[c] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kg	milligrams per kilogram	NA	not applicable
HI	hazard index	mg/kd-d	milligrams per kilogram per day	RME	reasonable maximum exposure
HQ	hazard quotient	mg/L	milligrams per liter		

Table D-62
Summary of Tier II RME Henry Site Human Health Risk Estimates - Fruits and Vegetables - Upland Soil and Groundwater

Analyte	Upland Soil Concentration[a] (mg/kg)			Groundwater Concentration[a] (mg/L)			Modeled Total Fruits and Vegetables Concentration (mg/kg)	Measured Non-Culturally Significant Plants Concentration (mg/kg)	Hypothetical Future Resident	
	Maximum	95% UCL	EPC[b]	Maximum	95% UCL	EPC[c]	EPC[d]	EPC[e]	ILCR	HQ
Antimony	9.15	4.81	4.81	NA	NA	NA	0.176	0.176	NA	**2.3**
Arsenic	45.5	24.9	24.9	0.00430	0.00227	0.00227	0.585	0.575	**2.0E-03**	**10**
Cadmium	59.5	32.5	32.5	NA	NA	NA	0.535	0.535	NA	**2.8**
Cobalt	11.9	7.74	7.74	0.0100	NC	0.0100	0.0859	0.0428	NA	**1.5**
Manganese	2,040	658	658	3.39	0.592	0.592	13.5	9.7	NA	0.50
Molybdenum	NA	NA	NA	0.110	0.0373	0.0373	7.31	7.08	NA	**7.6**
Nickel	425	212	212	NA	NA	NA	1.59	1.59	NA	0.41
Selenium	318	46.4	46.4	0.219	0.0479	0.0479	5.94	5.74	NA	**6.2**
Thallium	2.31	1.31	1.31	0.000900	0.000505	0.000505	0.0871	0.0850	NA	**45**
Uranium	74.4	40.5	40.5	NA	NA	NA	0.0490	0.0490	NA	**1.3**
Vanadium	584	212	212	NA	NA	NA	0.421	0.421	NA	0.44
Cumulative ILCR/HQ:									**2E-03**	**78**
IDEQ Point of Departure:									10^{-5}	1
USEPA Risk Range:									10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration and ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil and groundwater samples collected from Henry Site sampling locations.

[b] The soil EPC used to model fruits and vegetables concentration is the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration.

[c] The groundwater EPC used to model fruits and vegetables concentration is the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration.

[d] The fruits and vegetables EPC was modeled from the groundwater EPC and the measured plant EPC, where available, or the soil EPC using plant uptake factors as described in Table D-60 and Table D-61.

[e] The ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration measured in non-culturally significant plant samples in wet weight. The dry weight non-culturally significant data were converted to wet weight using an average moisture content of 66 percent.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
mg/L - milligrams per liter
NA - not applicable
NC - not calculated
USEPA - U. S. Environmental Protection Agency
RME - reasonable maximum exposure

Table D-63
Tier II CTE Henry Site Cancer Risk Calculation for a Current/Future Seasonal Rancher - Cattle - Upland Soil and Surface Water

Analyte	Upland Soil Concentration[a] (mg/kg)	Surface Water Concentration (mg/L)	Modeled Cattle Concentration from Soil (mg/kg)	Modeled Cattle Concentration from Surface Water (mg/kg)	Total Cattle Concentration (mg/kg)	Modeled Cattle Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Chemical-Specific Risk
Arsenic	24.9	0.00928	0.0141	0.000984	0.0151	2.3E-06	1.5E+00	**3.5E-06**
							ILCR	**4E-06**

Notes:

[a] Maximum detected concentration or the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil and surface water samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	mg/L	milligrams per liter
mg/kg	milligrams per kilogram	CTE	central tendency exposure

Table D-64
Tier II CTE Henry Site Noncancer Hazard Calculation for a Current/Future Seasonal Rancher - Cattle - Upland Soil and Surface Water

Analyte	Upland Soil Concentration[a] (mg/kg)	Surface Water Concentration[a] (mg/L)	Modeled Cattle Concentration from Soil (mg/kg)	Modeled Cattle Concentration from Surface Water (mg/kg)	Total Cattle Concentration (mg/kg)	Modeled Cattle Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Chemical-Specific HQ
Arsenic	24.9	0.00928	0.0141	0.000984	0.0151	2.6E-05	3.0E-04	0.086
Cobalt	7.74	0.00417	0.0318	0.00442	0.0363	6.2E-05	3.0E-04	0.21
Selenium	46.4	0.102	0.157	0.0811	0.238	4.1E-04	5.0E-03	0.081
Thallium	1.31	0.0000813	0.00750	0.000172	0.00767	1.3E-05	1.0E-05	**1.3**
							HI	**2**

Notes:

[a] Maximum detected concentration or the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil and surface water samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	mg/L	milligrams per liter
HQ	hazard quotient	CTE	central tendency exposure
mg/kg	milligrams per kilogram		

Table D-65
Summary of Tier II CTE Henry Site Human Health Risk Estimates - Cattle - Upland Soil and Surface Water

Analyte	Upland Soil Concentration[a] (mg/kg)			Surface Water Concentration[a] (mg/L)			Modeled Cattle Concentration (mg/kg)	Current/Future Seasonal Rancher	
	Maximum	95% UCL	EPC[b]	Maximum	95% UCL	EPC[b]	EPC[c]	ILCR	HQ
Arsenic	45.5	24.9	24.9	0.0224	0.00928	0.00928	0.0151	**3.5E-06**	0.086
Cobalt	11.9	7.74	7.74	0.0141	0.00417	0.00417	0.0363	NA	0.21
Selenium	318	46.4	46.4	0.970	0.102	0.102	0.238	NA	0.081
Thallium	2.31	1.31	1.31	0.000348	0.0000813	0.0000813	0.00767	NA	**1.3**
Cumulative ILCR/HQ:								**4E-06**	**2**
IDEQ Point of Departure:								10^{-5}	1
USEPA Risk Range:								10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration and ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil and surface water samples collected from Henry Site sampling locations.

[b] The upland soil and surface water EPCs used to model cattle concentration are the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration in those media.

[c] The cattle EPC was modeled from upland soil and surface water EPCs.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk

mg/kg - milligrams per kilogarm
mg/L - milligrams per liter
NA - not applicable
USEPA - U. S. Environmental Protection Agency
CTE - central tendency exposure

Table D-66
Tier II CTE Henry Site Cancer Risk Calculation for a Current/Future Seasonal Rancher - Cattle - Upland Soil and Groundwater

Analyte	Upland Soil Concentration[a] (mg/kg)	Groundwater Concentration (mg/L)	Modeled Cattle Concentration from Soil (mg/kg)	Modeled Cattle Concentration from Groundwater (mg/kg)	Total Cattle Concentration (mg/kg)	Modeled Cattle Ingestion Dose (mg/kg-d)	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b] Oral	Chemical-Specific Risk
Arsenic	24.9	0.00227	0.0141	0.000241	0.0143	2.2E-06	1.5E+00	**3.3E-06**
							ILCR	**3E-06**

Notes:

[a] Maximum detected concentration or the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil and groundwater samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	mg/L	milligrams per liter
mg/kg	milligrams per kilogram	CTE	central tendency exposure

Table D-67
Tier II CTE Henry Site Noncancer Hazard Calculation for a Current/Future Seasonal Rancher - Cattle - Upland Soil and Groundwater

Analyte	Upland Soil Concentration[a] (mg/kg)	Groundwater Concentration[a] (mg/L)	Modeled Cattle Concentration from Soil (mg/kg)	Modeled Cattle Concentration from Groundwater (mg/kg)	Total Cattle Concentration (mg/kg)	Modeled Cattle Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Chemical-Specific HQ
Arsenic	24.9	0.00227	0.0141	0.000241	0.0143	2.4E-05	3.0E-04	0.081
Cobalt	7.74	0.0100	0.0318	0.0106	0.0424	7.2E-05	3.0E-04	0.24
Selenium	46.4	0.0479	0.157	0.0381	0.195	3.3E-04	5.0E-03	0.066
Thallium	1.31	0.000505	0.00750	0.00107	0.00857	1.5E-05	1.0E-05	**1.5**
							HI	**2**

Notes:

[a] Maximum detected concentration or the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil and groundwater samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	mg/L	milligrams per liter
HQ	hazard quotient	CTE	central tendency exposure
mg/kg	milligrams per kilogram		

Table D-68
Summary of Tier II CTE Henry Site Human Health Risk Estimates - Cattle - Upland Soil and Groundwater

Analyte	Upland Soil Concentration[a] (mg/kg)			Groundwater Concentration[a] (mg/L)			Modeled Cattle Concentration (mg/kg)	Current/Future Seasonal Rancher	
	Maximum	95% UCL	EPC[b]	Maximum	95% UCL	EPC[b]	EPC[c]	ILCR	HQ
Arsenic	45.5	24.9	24.9	0.00430	0.00227	0.00227	0.0143	**3.3E-06**	0.081
Cobalt	11.9	7.74	7.74	0.0100	NC	0.0100	0.0424	NA	0.24
Selenium	318	46.4	46.4	0.219	0.0479	0.0479	0.195	NA	0.066
Thallium	2.31	1.31	1.31	0.000900	0.000505	0.000505	0.00857	NA	**1.5**
Cumulative ILCR/HQ:								**3E-06**	**2**
IDEQ Point of Departure:								10^{-5}	1
USEPA Risk Range:								10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration and ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil and groundwater samples collected from Henry Site sampling locations.

[b] The upland soil and groundwater EPCs used to model cattle concentrations are the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration in those media.

[c] The cattle EPC was modeled from upland soil and groundwater EPCs.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm

mg/kg - milligrams per kilogarm
mg/L - milligrams per liter
NA - not applicable
USEPA - U. S. Environmental Protection Agency
CTE - central tendency exposure

Table D-69
Tier II RME Henry Site Cancer Risk Calculation for a Current/Future Seasonal Rancher - Cattle - Upland Soil and Surface Water

Analyte	Upland Soil Concentration[a] (mg/kg)	Surface Water Concentration (mg/L)	Modeled Cattle Concentration from Soil (mg/kg)	Modeled Cattle Concentration from Surface Water (mg/kg)	Total Cattle Concentration (mg/kg)	Modeled Cattle Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Chemical-Specific Risk
Arsenic	24.9	0.00928	0.0141	0.000984	0.0151	3.4E-05	1.5E+00	**5.0E-05**
							ILCR	**5E-05**

Notes:

[a] Maximum detected concentration or the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil and surface water samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	mg/L	milligrams per liter
mg/kg	milligrams per kilogram	RME	reasonable maximum exposure

Table D-70
Tier II RME Henry Site Noncancer Hazard Calculation for a Current/Future Seasonal Rancher - Cattle - Upland Soil and Surface Water

Analyte	Upland Soil Concentration[a] (mg/kg)	Surface Water Concentration[a] (mg/L)	Modeled Cattle Concentration from Soil (mg/kg)	Modeled Cattle Concentration from Surface Water (mg/kg)	Total Cattle Concentration (mg/kg)	Modeled Cattle Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Chemical-Specific HQ
Arsenic	24.9	0.00928	0.0141	0.000984	0.0151	9.8E-05	3.0E-04	0.33
Cobalt	7.74	0.00417	0.0318	0.00442	0.0363	2.4E-04	3.0E-04	0.79
Selenium	46.4	0.102	0.157	0.0811	0.238	1.5E-03	5.0E-03	0.31
Thallium	1.31	0.0000813	0.00750	0.000172	0.00767	5.0E-05	1.0E-05	**5.0**
							HI	**6**

Notes:

[a] Maximum detected concentration or the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil and surface water samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	mg/L	milligrams per liter
HQ	hazard quotient	RME	reasonable maximum exposure
mg/kg	milligrams per kilogram		

Table D-71
Summary of Tier II RME Henry Site Human Health Risk Estimates - Cattle - Upland Soil and Surface Water

Analyte	Upland Soil Concentration[a] (mg/kg)			Surface Water Concentration[a] (mg/L)			Modeled Cattle Concentration (mg/kg)	Current/Future Seasonal Rancher	
	Maximum	95% UCL	EPC[b]	Maximum	95% UCL	EPC[b]	EPC[c]	ILCR	HQ
Arsenic	45.5	24.9	24.9	0.0224	0.00928	0.00928	0.0151	**5.0E-05**	0.33
Cobalt	11.9	7.74	7.74	0.0141	0.00417	0.00417	0.0363	NA	0.79
Selenium	318	46.4	46.4	0.970	0.102	0.102	0.238	NA	0.31
Thallium	2.31	1.31	1.31	0.000348	0.0000813	0.0000813	0.00767	NA	**5.0**
							Cumulative ILCR/HQ:	**5E-05**	**6**
							IDEQ Point of Departure:	10^{-5}	1
							USEPA Risk Range:	10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration and ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil and surface water samples collected from Henry Site sampling locations.

[b] The upland soil and surface water EPCs used to model cattle concentration are the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration in those media.

[c] The cattle EPC was modeled from upland soil and surface water EPCs.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
mg/L - milligrams per liter
NA - not applicable
USEPA - U. S. Environmental Protection Agency
RME - reasonable maximum exposure

Table D-72
Tier II RME Henry Site Cancer Risk Calculation for a Current/Future Seasonal Rancher - Cattle - Upland Soil and Groundwater

Analyte	Upland Soil Concentration[a] (mg/kg)	Groundwater Concentration (mg/L)	Modeled Cattle Concentration from Soil (mg/kg)	Modeled Cattle Concentration from Groundwater (mg/kg)	Total Cattle Concentration (mg/kg)	Modeled Cattle Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Chemical-Specific Risk
Arsenic	24.9	0.00227	0.0141	0.000241	0.0143	3.2E-05	1.5E+00	**4.8E-05**
							ILCR	**5E-05**

Notes:

[a] Maximum detected concentration or the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil and groundwater samples collected from Henry Site sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	mg/L	milligrams per liter
mg/kg	milligrams per kilogram	RME	reasonable maximum exposure

Table D-73

Tier II RME Henry Site Noncancer Hazard Calculation for a Current/Future Seasonal Rancher - Cattle - Upland Soil and Groundwater

Analyte	Upland Soil Concentration[a] (mg/kg)	Groundwater Concentration[a] (mg/L)	Modeled Cattle Concentration from Soil (mg/kg)	Modeled Cattle Concentration from Groundwater (mg/kg)	Total Cattle Concentration (mg/kg)	Modeled Cattle Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Chemical-Specific HQ
Arsenic	24.9	0.00227	0.0141	0.000241	0.0143	9.3E-05	3.0E-04	0.31
Cobalt	7.74	0.0100	0.0318	0.0106	0.0424	2.8E-04	3.0E-04	0.92
Selenium	46.4	0.0479	0.157	0.0381	0.195	1.3E-03	5.0E-03	0.25
Thallium	1.31	0.000505	0.00750	0.00107	0.00857	5.6E-05	1.0E-05	**5.6**
							HI	**7**

Notes:

[a] Maximum detected concentration or the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil and groundwater samples collected from Henry Site sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	mg/L	milligrams per liter
HQ	hazard quotient	RME	reasonable maximum exposure
mg/kg	milligrams per kilogram		

Table D-74

Summary of Tier II RME Henry Site Human Health Risk Estimates - Cattle - Upland Soil and Groundwater

	Upland Soil Concentration[a] (mg/kg)			Groundwater Concentration[a] (mg/L)			Modeled Cattle Concentration (mg/kg)	Current/Future Seasonal Rancher	
Analyte	**Maximum**	**95% UCL**	**EPC[b]**	**Maximum**	**95% UCL**	**EPC[b]**	**EPC[c]**	**ILCR**	**HQ**
Arsenic	45.5	24.9	24.9	0.00430	0.00227	0.00227	0.0143	**4.8E-05**	0.31
Cobalt	11.9	7.74	7.74	0.0100	NC	0.0100	0.0424	NA	0.92
Selenium	318	46.4	46.4	0.219	0.0479	0.0479	0.195	NA	0.25
Thallium	2.31	1.31	1.31	0.000900	0.000505	0.000505	0.00857	NA	**5.6**
							Cumulative ILCR/HQ:	**5E-05**	**7**
							IDEQ Point of Departure:	10^{-5}	1
							USEPA Risk Range:	10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration and ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil and groundwater samples collected from Henry Site sampling locations.

[b] The upland soil and groundwater EPCs used to model cattle concentrations are the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration in those media.

[c] The cattle EPC was modeled from upland soil and groundwater EPCs.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
mg/L - milligrams per liter
NA - not applicable
NC - not calculated
USEPA - U. S. Environmental Protection Agency
RME - reasonable maximum exposure

Table D-75
Tier II CTE Henry Site Cancer Risk Calculation for a Current/Future Native American - Culturally Significant Aquatic Plants

Analyte	Sediment Concentration[a] (mg/kg)	Surface Water Concentration[a] (mg/L)	Modeled Culturally Significant Aquatic Plant Concentration from Sediment (mg/kg dry weight)	Modeled Culturally Significant Aquatic Plant Concentration from Sediment [b] (mg/kg wet weight)	Modeled Plant Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [c] Oral	Chemical-Specific Risk
Arsenic	7.49	0.00928	0.281	0.0962	1.1E-05	1.5E+00	**1.7E-05**
						ILCR	**2E-05**

Notes:

[a] Maximum detected concentration or 95% UCL on the mean concentration measured in sediment or surface water samples collected from Henry Site sampling locations.

[b] Dry weight plant concentrations were converted to wet weight plant concentrations assuming a plant moisture content of 65.7 percent.

[c] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

95% UCL	95 percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	mg/L	milligrams per liter
mg/kg	milligrams per kilogram	CTE	central tendency exposure

Table D-76

Tier II CTE Henry Site Noncancer Hazard Calculation for a Current/Future Native American - Culturally Significant Aquatic Plants

Analyte	Sediment Concentration[a] (mg/kg)	Surface Water Concentration (mg/L)	Modeled Culturally Significant Aquatic Plant Concentration from Sediment (mg/kg dry weight)	Modeled Culturally Significant Aquatic Plant Concentration from Sediment [b] (mg/kg wet weight)	Modeled Plant Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [c] Oral	Chemical-Specific HQ
Antimony	6.03	0.000657	0.213	0.0728	7.3E-05	4.0E-04	0.18
Arsenic	7.49	0.00928	0.281	0.0962	9.7E-05	3.0E-04	0.32
Cadmium	27.1	0.00371	3.766	1.29	1.3E-03	1.0E-03	**1.3**
Manganese	1,130	1.17	89.3	30.6	3.1E-02	1.4E-01	0.22
Nickel	199	0.138	5.67	1.94	2.0E-03	2.0E-02	0.098
Selenium	49.8	0.102	38.012	13.0	1.3E-02	5.0E-03	**2.6**
Thallium	1.12	0.0000813	0.00446	0.00153	1.5E-06	1.0E-05	0.15
Uranium	30.6	0.00586	0.2598	0.0890	9.0E-05	2.0E-04	0.45
Vanadium	231	0.00989	1.12	0.383	3.9E-04	5.0E-03	0.077
Zinc	1,385	0.484	266	91.0	9.2E-02	3.0E-01	0.31
						HI	**6**

Notes:

[a] Maximum detected concentration or 95% UCL on the mean concentration measured in sediment or surface water samples collected from Henry Site sampling locations.

[b] Dry weight plant concentrations were converted to wet weight plant concentrations assuming a plant moisture content of 65.7 percent.

[c] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

95% UCL	95 percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	mg/L	milligrams per liter
HQ	hazard quotient	CTE	central tendency exposure
mg/kg	milligrams per kilogram		

Table D-77
Summary of Tier II CTE Henry Site Human Health Risk Estimates - Culturally Significant Aquatic Plants

Analyte	Sediment Concentration[a] (mg/kg)			Surface Water Concentration[a] (mg/L)			Modeled Culturally Significant Aquatic Plants Concentration (mg/kg)	Current/Future Native American	
	Maximum	95% UCL	EPC[b]	Maximum	95% UCL	EPC	EPC[c]	ILCR	HQ
Antimony	8.50	6.03	6.03	0.00230	0.000657	0.000657	0.0728	NA	0.18
Arsenic	10.6	7.49	7.49	0.0224	0.00928	0.00928	0.0962	**1.7E-05**	0.32
Cadmium	104	27.1	27.1	0.0352	0.00371	0.00371	1.29	NA	**1.3**
Manganese	2,580	1,130	1,130	2.4	1.17	1.17	30.6	NA	0.22
Nickel	1,110	199	199	1.26	0.138	0.138	1.94	NA	0.098
Selenium	148	49.8	49.8	0.970	0.102	0.102	13.0	NA	**2.6**
Thallium	2.17	1.12	1.12	0.000348	0.0000813	0.0000813	0.00153	NA	0.15
Uranium	90.0	30.6	30.6	0.0206	0.00586	0.00586	0.0890	NA	0.45
Vanadium	940	231	231	0.0885	0.00989	0.00989	0.383	NA	0.077
Zinc	7,940	1,385	1,385	4.73	0.484	0.484	91.0	NA	0.31
							Cumulative ILCR/HQ:	**2E-05**	**6**
							IDEQ Point of Departure:	10^{-5}	1
							USEPA Risk Range:	10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration and ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in sediment or surface water samples collected from Henry Site sampling locations.

[b] The sediment EPC used to model culturally significant aquatic plants concentration is the 95% UCL on the mean concentration or the maximum detected concentration.

[c] The culturally significant aquatic plants EPCs for surface water constituents of potential concern were modeled from the sediment EPCs using sediment-to-plant uptake factors when sediment data were available.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
mg/L - milligrams per liter
NA - not applicable
USEPA - U. S. Environmental Protection Agency
CTE - central tendency exposure

Table D-78
Tier II RME Henry Site Cancer Risk Calculation for a Current/Future Native American - Culturally Significant Aquatic Plants

Analyte	Sediment Concentration[a] (mg/kg)	Surface Water Concentration[a] (mg/L)	Modeled Culturally Significant Aquatic Plant Concentration from Sediment (mg/kg dry weight)	Modeled Culturally Significant Aquatic Plant Concentration from Sediment [b] (mg/kg wet weight)	Modeled Plant Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [c] Oral	Chemical-Specific Risk
Arsenic	7.49	0.00928	0.281	0.0962	2.1E-04	1.5E+00	**3.2E-04**
						ILCR	**3E-04**

Notes:

[a] Maximum detected concentration or 95% UCL on the mean concentration measured in sediment or surface water samples collected from Henry Site sampling locations.

[b] Dry weight plant concentrations were converted to wet weight plant concentrations assuming a plant moisture content of 65.7 percent.

[c] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

95% UCL	95 percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	mg/L	milligrams per liter
mg/kg	milligrams per kilogram	RME	reasonable maximum exposure

Table D-79
Tier II RME Henry Site Noncancer Hazard Calculation for a Current/Future Native American - Culturally Significant Aquatic Plants

Analyte	Sediment Concentration[a] (mg/kg)	Surface Water Concentration (mg/L)	Modeled Culturally Significant Aquatic Plant Concentration from Sediment (mg/kg dry weight)	Modeled Culturally Significant Aquatic Plant Concentration from Sediment [b] (mg/kg wet weight)	Modeled Plant Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [c] Oral	Chemical-Specific HQ
Antimony	6.03	0.000657	0.213	0.0728	3.8E-04	4.0E-04	0.95
Arsenic	7.49	0.00928	0.281	0.0962	5.0E-04	3.0E-04	**1.7**
Cadmium	27.1	0.00371	3.77	1.29	6.7E-03	1.0E-03	**6.7**
Manganese	1,130	1.17	89.3	30.6	1.6E-01	1.4E-01	**1.1**
Nickel	199	0.138	5.67	1.94	1.0E-02	2.0E-02	0.51
Selenium	49.8	0.102	38.0	13.0	6.8E-02	5.0E-03	**14**
Thallium	1.12	0.0000813	0.00446	0.00153	7.9E-06	1.0E-05	0.79
Uranium	30.6	0.00586	0.260	0.0890	4.6E-04	2.0E-04	**2.3**
Vanadium	231	0.00989	1.12	0.383	2.0E-03	5.0E-03	0.40
Zinc	1,385	0.484	266	91.0	4.7E-01	3.0E-01	**1.6**
						HI	**30**

Notes:

[a] Maximum detected concentration or 95% UCL on the mean concentration measured in sediment or surface water samples collected from Henry Site sampling locations.

[b] Dry weight plant concentrations were converted to wet weight plant concentrations assuming a plant moisture content of 65.7 percent.

[c] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

95% UCL	95 percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	mg/L	milligrams per liter
HQ	hazard quotient	RME	reasonable maximum exposure
mg/kg	milligrams per kilogram		

Table D-80
Summary of Tier II RME Henry Site Human Health Risk Estimates - Culturally Significant Aquatic Plants

Analyte	Sediment Concentration[a] (mg/kg)			Surface Water Concentration[a] (mg/L)			Modeled Culturally Significant Aquatic Plants Concentration (mg/kg)	Current/Future Native American	
	Maximum	95% UCL	EPC[b]	Maximum	95% UCL	EPC	EPC[c]	ILCR	HQ
Antimony	8.50	6.03	6.03	0.00230	0.000657	0.000657	0.0728	NA	0.95
Arsenic	10.6	7.49	7.49	0.0224	0.00928	0.00928	0.0962	**3.2E-04**	**1.7**
Cadmium	104	27.1	27.1	0.0352	0.00371	0.00371	1.29	NA	**6.7**
Manganese	2,580	1,130	1,130	2.4	1.17	1.17	30.6	NA	**1.1**
Nickel	1,110	199	199	1.26	0.138	0.138	1.94	NA	0.51
Selenium	148	49.8	49.8	0.970	0.102	0.102	13.0	NA	**14**
Thallium	2.17	1.12	1.12	0.000348	0.0000813	0.0000813	0.00153	NA	0.79
Uranium	90.0	30.6	30.6	0.0206	0.00586	0.00586	0.0890	NA	**2.3**
Vanadium	940	231	231	0.0885	0.00989	0.00989	0.383	NA	0.40
Zinc	7,940	1,385	1,385	4.73	0.484	0.484	91.0	NA	**1.6**
Cumulative ILCR/HQ:								**3E-04**	**30**
IDEQ Point of Departure:								10^{-5}	1
USEPA Risk Range:								10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration and ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in sediment or surface water samples collected from Henry Site sampling locations.

[b] The sediment EPC used to model culturally significant aquatic plants concentration is the 95% UCL on the mean concentration or the maximum detected concentration.

[c] The culturally significant aquatic plants EPCs for surface water constituents of potential concern were modeled from the sediment EPCs using sediment-to-plant uptake factors when sediment data were available.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk

mg/kg - milligrams per kilogarm
mg/L - milligrams per liter
NA - not applicable
USEPA - U. S. Environmental Protection Agency
RME - reasonable maximum exposure

Table D-81
Tier II CTE Henry Site Cancer Risk Calculation - Fish Consumption
Recreational Fisher, Native American and Hypothetical Future Resident

Analyte	Sediment Concentration[a] (mg/kg)	Surface Water Concentration[a] (mg/L)	Modeled Fish Concentration from Sediment (mg/kg wet weight)	Modeled Fish Concentration from Surface Water (mg/kg wet weight)	Fish Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Chemical-Specific Risk
Arsenic	1.99	0.000750	0.00478	0.0855	5.7E-07	1.5E+00	8.5E-07
						ILCR	9E-07

Notes:

[a] Maximum detected concentration or 95% UCL on the mean concentration measured in sediment or surface water samples collected from Henry Site sampling locations where fish have been observed or are likely to be present.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

95% UCL	95 percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	mg/L	milligrams per liter
mg/kg	milligrams per kilogram	CTE	central tendency exposure

Table D-82
Tier II CTE Henry Site Noncancer Hazard Calculation - Fish Consumption
Recreational Fisher, Native American and Hypothetical Future Resident

Analyte	Sediment Concentration[a] (mg/kg)	Surface Water Concentration (mg/L)	Modeled Fish Concentration from Sediment (mg/kg wet weight)	Modeled Fish Concentration from Surface Water (mg/kg wet weight)	Fish Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Chemical-Specific HQ
Antimony	4.70	ND	4.70	NA	2.7E-04	4.0E-04	0.68
Arsenic	1.99	0.000750	0.00478	0.0855	5.0E-06	3.0E-04	0.017
Thallium	0.122	ND	0.122	NA	7.1E-06	1.0E-05	0.71
						HI	1

Notes:

[a] Maximum detected concentration or 95% UCL on the mean concentration measured in sediment or surface water samples collected from Henry Site sampling locations where fish have been observed or are likely to be present.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

95% UCL	95 percent upper confidence limit
HI	hazard index
HQ	hazard quotient
mg/kg	milligrams per kilogram
mg/kg-d	milligrams per kilogram per day
mg/L	milligrams per liter
CTE	central tendency exposure

Table D-83
Summary of Tier II CTE Henry Site Human Health Risk Estimates - Fish

Analyte	Sediment Concentration[a] (mg/kg)			Surface Water Concentration[a] (mg/L)			Modeled Fish Concentration (mg/kg)	Current/Future Recreational Fisher and Native American and Hypothetical Future Resident	
	Maximum	95% UCL	EPC[b]	Maximum	95% UCL	EPC[b]	EPC[c]	ILCR	HQ
Antimony	4.70	NC	4.70	ND	NC	ND	NA	NA	0.68
Arsenic	1.99	NC	1.99	0.000750	NC	0.000750	0.0855	8.5E-07	0.017
Thallium	0.122	NC	0.122	ND	NC	ND	NA	NA	0.71
Cumulative ILCR/HQ:								9E-07	1
IDEQ Point of Departure:								10^{-5}	1
USEPA Risk Range:								10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration and ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in sediment or surface water samples collected from Henry Site sampling locations where fish have been observed or are likely to be present.

[b] The sediment or surface water EPC used to model the fish concentration is the 95% UCL on the mean concentration or the maximum detected concentration.

[c] The fish EPCs for both surface water and sediment constituents of potential concern were modeled from the surface water EPCs using surface water-to-fish uptake factors when surface water data were available, otherwise they were modeled from the sediment EPCs using sediment-to-fish uptake factors.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk

mg/kg - milligrams per kilogarm
mg/L - milligrams per liter
NA - not applicable
USEPA - U. S. Environmental Protection Agency
CTE - central tendency exposure

Table D-84
Tier II RME Henry Site Cancer Risk Calculation - Fish Consumption
Recreational Fisher, Native American and Hypothetical Future Resident

Analyte	Sediment Concentration[a] (mg/kg)	Surface Water Concentration[a] (mg/L)	Modeled Fish Concentration from Sediment (mg/kg wet weight)	Modeled Fish Concentration from Surface Water (mg/kg wet weight)	Fish Ingestion Dose (mg/kg-d)	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b] Oral	Chemical-Specific Risk
Arsenic	1.99	0.000750	0.00478	0.0855	1.9E-05	1.5E+00	**2.8E-05**
						ILCR	**3E-05**

Notes:

[a] Maximum detected concentration or 95% UCL on the mean concentration measured in sediment or surface water samples collected from Henry Site sampling locations where fish have been observed or are likely to be present.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

95% UCL	95 percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	mg/L	milligrams per liter
mg/kg	milligrams per kilogram	RME	reasonable maximum exposure

Table D-85
Tier II RME Henry Site Noncancer Hazard Calculation - Fish Consumption
Recreational Fisher, Native American and Hypothetical Future Resident

Analyte	Sediment Concentration[a] (mg/kg)	Surface Water Concentration (mg/L)	Modeled Fish Concentration from Sediment (mg/kg wet weight)	Modeled Fish Concentration from Surface Water (mg/kg wet weight)	Fish Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d)[b] Oral	Chemical-Specific HQ
Antimony	4.70	ND	4.70	NA	2.4E-03	4.0E-04	**6.0**
Arsenic	1.99	0.000750	0.00478	0.0855	4.3E-05	3.0E-04	0.145
Thallium	0.122	ND	0.122	NA	6.2E-05	1.0E-05	**6.2**
						HI	**12**

Notes:

[a] Maximum detected concentration or 95% UCL on the mean concentration measured in sediment or surface water samples collected from Henry Site sampling locations where fish have been observed or are likely to be present.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

95% UCL	95 percent upper confidence limit
HI	hazard index
HQ	hazard quotient
mg/kg	milligrams per kilogram
mg/kg-d	milligrams per kilogram per day
mg/L	milligrams per liter
RME	reasonable maximum exposure

Table D-86
Summary of Tier II RME Henry Site Human Health Risk Estimates - Fish

Analyte	Sediment Concentration[a] (mg/kg)			Surface Water Concentration[a] (mg/L)			Modeled Fish Concentration (mg/kg)	Current/Future Recreational Fisher and Native American and Hypothetical Future Resident	
	Maximum	95% UCL	EPC[b]	Maximum	95% UCL	EPC[b]	EPC[c]	ILCR	HQ
Antimony	4.70	NC	4.70	ND	NC	ND	NA	NA	**6.0**
Arsenic	1.99	NC	1.99	0.000750	NC	0.000750	0.0855	**2.8E-05**	0.14
Thallium	0.122	NC	0.122	ND	NC	ND	NA	NA	**6.2**
Cumulative ILCR/HQ:								**3E-05**	**12**
IDEQ Point of Departure:								10^{-5}	1
USEPA Risk Range:								10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration and ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in sediment or surface water samples collected from Henry Site sampling locations where fish have been observed or are likely to be present.

[b] The sediment or surface water EPC used to model the fish concentration is the 95% UCL on the mean concentration or the maximum detected concentration.

[c] The fish EPCs for both surface water and sediment constituents of potential concern were modeled from the surface water EPCs using surface water-to-fish uptake factors when surface water data were available, otherwise they were modeled from the sediment EPCs using sediment-to-fish uptake factors.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk

mg/kg - milligrams per kilogarm
mg/L - milligrams per liter
NA - not applicable
USEPA - U. S. Environmental Protection Agency
RME - reasonable maximum exposure

Table D-87

Tier II CTE Henry Site Radiological Risk Calculation for Current/Future Native Americans

Medium	Radium-226 EPC[a]		Pathway-Specific Radium-226 PRG [b]		Pathway-Specific Radium-226 Risk	Total Medium Radium-226 Risk
Culturally Significant Plants						
Upland Soil	12.6	pCi/g	0.477	pCi/g	**2.6E-05**	**2.6E-05**
Elk [c]						
Upland Soil	NA	pCi/g	45,333	pCi/g	NA	NA
Upland Soil						
Incidental Ingestion	12.6	pCi/g	16.8	pCi/g	7.5E-07	**1.8E-05**
External Exposure	12.6	pCi/g	0.716	pCi/g	**1.8E-05**	
Inhalation of Particulates	12.6	pCi/g	214,000	pCi/g	5.9E-11	
Aquatic Plants [d]						
Sediment	21.3	pCi/g	0.912	pCi/g	**2.3E-05**	**2.3E-05**
					Total Site Media Risk:	**4E-05**
					IDEQ Point-of-departure:	**10^{-5}**
					USEPA Risk Range:	**10^{-6} - 10^{-4}**

Notes:

[a] The upland soil EPC was calculated from gamma count measurements at the Henry Site according to the regression model described in the on-site and background areas radiological and soil investigation summary report (MWH, 2015). The sediment EPC was calculated based on the same total uranium to radium-226 conversion factor used to calculate water EPCs, with an additional uranium-238 to radium-226 ratio of 0.5 to 1, based on the approximate mean ratio for upland soils described in MWH (2015), applied.

[b] Preliminary Remediation Goals (PRGs) for radium-226+daughter products were calculated using the USEPA's online PRG calculator for radionuclides.

[c] Ingestion of elk was not evaluated in the Tier II HHRA because risk associated with this pathway in the Tier I HHRA did not exceed $1x10^{-6}$.

[d] Consistent with the evaluation for metals, the cumulative ILCR for the Native American includes the larger of the ILCR for radium-226 in upland or aquatic culturally significant plants. Because the PRG for aquatic plants is greater than the PRG for upland plants, aquatic plants are not included in the cumulative ILCR.

Bold indicates ILCR estimates above USEPA's risk management range or IDEQ's point of departure

CTE - central tendency estimate
EPC - Exposure point concentration
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
pCi/g - picocuries per gram
PRG - Preliminary Remediation Goal
USEPA - United States Environmental Protection Agency

Table D-88

Tier II CTE Henry Site Radiological Risk Calculation for Hypothetical Future Residents

Medium	Radium-226 EPC[a]		Pathway-Specific Radium-226 PRG [b]		Pathway-Specific Radium-226 Risk	Total Medium Radium-226 Risk
Fruits and Vegetables						
Upland Soil	12.6	pCi/g	0.477	pCi/g	**2.6E-05**	**2.6E-05**
Upland Soil						
Incidental Ingestion	12.6	pCi/g	16.8	pCi/g	7.5E-07	**1.8E-05**
External Exposure	12.6	pCi/g	0.716	pCi/g	**1.8E-05**	
Inhalation of Particulates	12.6	pCi/g	214,000	pCi/g	5.9E-11	
Medium	**Radon-222 EPC[a]**		**Pathway-Specific Radon-222 PRG [b]**		**Pathway-Specific Radon-222 Risk**	**Total Medium Radon-222 Risk**
Indoor Air	8,084	pCi/m^3	0.906	pCi/m^3	**8.9E-03**	**8.9E-03**
					Total Site Media Risk:	**9E-03**
					IDEQ Point-of-departure:	**10^{-5}**
					USEPA Risk Range:	**10^{-6} - 10^{-4}**

Notes:

[a] The upland soil EPC was calculated from gamma count measurements at the Henry Site according to the regression model described in the on-site and background areas radiological and soil investigation summary report (MWH, 2015). The indoor air EPC was calculated from radon flux measurements from background sample locations (MWH, 2015).

[b] Preliminary Remediation Goals (PRGs) for radium-226+daughter products and radon-222+daughter products were calculated using the USEPA's online PRG calculator for radionuclides.

Bold indicates ILCR estimates above USEPA's risk management range or IDEQ's point of departure

CTE - central tendency estimate
EPC - Exposure point concentration
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
NA - not applicable
pCi/g - picocuries per gram
PRG - Preliminary Remediation Goal
USEPA - United States Environmental Protection Agency

Table D-89

Tier II CTE Henry Site Radiological Risk Calculation for a Current/Future Seasonal Rancher

Medium	Radium-226 EPC[a]		Pathway-Specific Radium-226 PRG [b]		Pathway-Specific Radium-226 Risk	Total Medium Radium-226 Risk
Cattle						
Upland Soil	12.6	pCi/g	9.04	pCi/g	**1.4E-06**	**1.4E-06**
Upland Soil						
Incidental Ingestion	12.6	pCi/g	51.4	pCi/g	2.4E-07	**2.8E-05**
External Exposure	12.6	pCi/g	0.455	pCi/g	**2.8E-05**	
Inhalation of Particulates	12.6	pCi/g	122,000	pCi/g	1.0E-10	
					Total Site Media Risk:	**3E-05**
					IDEQ Point-of-departure:	**10^{-5}**
					USEPA Risk Range:	**10^{-6} - 10^{-4}**

Notes:

[a] The upland soil EPC was calculated from gamma count measurements at the Henry Site according to the regression model described in the on-site and background areas radiological and soil investigation summary report (MWH, 2015).

[b] Preliminary Remediation Goals (PRGs) for radium-226+daughter products were calculated using the USEPA's online PRG calculator for radionuclides.

Bold indicates ILCR estimates above USEPA's risk management range or IDEQ's point of departure

CTE - central tendency estimate
EPC - Exposure point concentration
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
NA - not applicable
pCi/g - picocuries per gram
pCi/L - picocuries per liter
PRG - Preliminary Remediation Goal
RME - reasonable maximum exposure
USEPA - United States Environmental Protection Agency

Table D-90

Tier II CTE Henry Site Radiological Risk Calculation for a Current/Future Recreational Hunter

Medium	Radium-226 EPC[a]		Pathway-Specific Radium-226 PRG [b]		Pathway-Specific Radium-226 Risk	Total Medium Radium-226 Risk
Elk [c]						
Upland Soil	NA	pCi/g	351	pCi/g	NA	NA
Upland Soil						
Incidental Ingestion	12.6	pCi/g	578	pCi/g	2.2E-08	**7.4E-06**
External Exposure	12.6	pCi/g	1.71	pCi/g	**7.3E-06**	
Inhalation of Particulates	12.6	pCi/g	459,000	pCi/g	2.7E-11	
					Total Site Media Risk:	**7E-06**
					IDEQ Point-of-departure:	**10^{-5}**
					USEPA Risk Range:	**10^{-6} - 10^{-4}**

Notes:

[a] The upland soil EPC was calculated from gamma count measurements at the Henry Site according to the regression model described in the on-site and background areas radiological and soil investigation summary

[b] Preliminary Remediation Goals (PRGs) for radium-226+daughter products were calculated using the USEPA's online PRG calculator for radionuclides.

[c] Ingestion of elk was not evaluated in the Tier II HHRA because risks associated with this pathway in the Tier I HHRA did not exceed $1x10^{-6}$.

Bold indicates ILCR estimates above USEPA's risk management range or IDEQ's point of departure

CTE - central tendency estimate
EPC - Exposure point concentration
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
pCi/g - picocuries per gram
pCi/L - picocuries per liter
PRG - Preliminary Remediation Goal
RME - reasonable maximum exposure
USEPA - United States Environmental Protection Agency

Table D-91

Tier II CTE Henry Site Radiological Risk Calculation for a Current/Future Recreational Camper / Hiker

Medium	Radium-226 EPC[a]		Pathway-Specific Radium-226 PRG [b]		Pathway-Specific Radium-226 Risk	Total Medium Radium-226 Risk
Upland Soil						
Incidental Ingestion	12.6	pCi/g	1,030	pCi/g	1.2E-08	**3.5E-06**
External Exposure	12.6	pCi/g	3.64	pCi/g	**3.5E-06**	
Inhalation of Particulates	12.6	pCi/g	1,090,000	pCi/g	1.2E-11	
					Total Site Media Risk:	**3E-06**
					IDEQ Point-of-departure:	**10^{-5}**
					USEPA Risk Range:	**10^{-6} - 10^{-4}**

Notes:

[a] The upland soil EPC was calculated from gamma count measurements at the Henry Site according to the regression model described in the on-site and background areas radiological and soil investigation summary report (MWH, 2015).

[b] Preliminary Remediation Goals (PRGs) for radium-226+daughter products were calculated using the USEPA's online PRG calculator for radionuclides.

Bold indicates ILCR estimates above USEPA's risk management range or IDEQ's point of departure

CTE - central tendency estimate
EPC - Exposure point concentration
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
pCi/g - picocuries per gram
PRG - Preliminary Remediation Goal
RME - reasonable maximum exposure
USEPA - United States Environmental Protection Agency

Table D-92

Tier II RME Henry Site Radiological Risk Calculation for Current/Future Native Americans

Medium	Radium-226 EPC[a]		Pathway-Specific Radium-226 PRG [b]		Pathway-Specific Radium-226 Risk	Total Medium Radium-226 Risk
Culturally Significant Plants						
Upland Soil	12.6	pCi/g	0.0248	pCi/g	**5.1E-04**	**5.1E-04**
Elk [c]						
Upland Soil	NA	pCi/g	57.3	pCi/g	NA	NA
Upland Soil						
Incidental Ingestion	12.6	pCi/g	1.53	pCi/g	**8.2E-06**	**2.0E-04**
External Exposure	12.6	pCi/g	0.0650	pCi/g	**1.9E-04**	
Inhalation of Particulates	12.6	pCi/g	19,400	pCi/g	6.5E-10	
Aquatic Plants [d]						
Sediment	21.3	pCi/g	0.0474	pCi/g	**4.5E-04**	**4.5E-04**
					Total Site Media Risk:	**7E-04**
					IDEQ Point-of-departure:	**10^{-5}**
					USEPA Risk Range:	**10^{-6} - 10^{-4}**

Notes:

[a] The upland soil EPC was calculated from gamma count measurements at the Henry Site according to the regression model described in the on-site and background areas radiological and soil investigation summary report (MWH, 2015). The sediment EPC was calculated based on the same total uranium to radium-226 conversion factor used to calculate water EPCs, with an additional uranium-238 to radium-226 ratio of 0.5 to 1, based on the approximate mean ratio for upland soils described in MWH (2015), applied.

[b] Preliminary Remediation Goals (PRGs) for radium-226+daughter products were calculated using the USEPA's online PRG calculator for radionuclides.

[c] Ingestion of elk was not evaluated in the Tier II HHRA because risk associated with this pathway in the Tier I HHRA did not exceed $1x10^{-6}$.

[d] Consistent with the evaluation for metals, the cumulative ILCR for the Native American includes the larger of the ILCR for radium-226 in upland or aquatic culturally significant plants. Because the PRG for aquatic plants is greater than the PRG for upland plants, aquatic plants are not included in the cumulative ILCR.

Bold indicates ILCR estimates above USEPA's risk management range or IDEQ's point of departure

EPC - Exposure point concentration
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
pCi/g - picocuries per gram
PRG - Preliminary Remediation Goal
RME - reasonable maximum exposure
USEPA - United States Environmental Protection Agency

Table D-93

Tier II RME Henry Site Radiological Risk Calculation for Hypothetical Future Residents

Medium	Radium-226 EPC[a]		Pathway-Specific Radium-226 PRG [b]		Pathway-Specific Radium-226 Risk	Total Medium Radium-226 Risk
Fruits and Vegetables						
Upland Soil	12.6	pCi/g	0.0248	pCi/g	**5.1E-04**	**5.1E-04**
Upland Soil						
Incidental Ingestion	12.6	pCi/g	1.53	pCi/g	**8.2E-06**	**2.0E-04**
External Exposure	12.6	pCi/g	0.0650	pCi/g	**1.9E-04**	
Inhalation of Particulates	12.6	pCi/g	19,400	pCi/g	6.5E-10	
Medium	**Radon-222 EPC[a]**		**Pathway-Specific Radon-222 PRG [b]**		**Pathway-Specific Radon-222 Risk**	**Total Medium Radon-222 Risk**
Indoor Air	8,084	pCi/m^3	0.242	pCi/m^3	**3.3E-02**	**3.3E-02**
					Total Site Media Risk:	**3E-02**
					IDEQ Point-of-departure:	**10^{-5}**
					USEPA Risk Range:	**10^{-6} - 10^{-4}**

Notes:

[a] The upland soil EPC was calculated from gamma count measurements at the Henry Site according to the regression model described in the on-site and background areas radiological and soil investigation summary report (MWH, 2015). The indoor air EPC was calculated from radon flux measurements from background sample locations (MWH, 2015).

[b] Preliminary Remediation Goals (PRGs) for radium-226+daughter products and radon-222+daughter products were calculated using the USEPA's online PRG calculator for radionuclides.

[c] Direct contact pathways for surface water were not evaluated in the Tier II HHRA because risks associated with these pathways in the Tier I HHRA did not exceed $1x10^{-6}$.

Bold indicates ILCR estimates above USEPA's risk management range or IDEQ's point of departure

EPC - Exposure point concentration
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
NA - not applicable
pCi/g - picocuries per gram
PRG - Preliminary Remediation Goal
RME - reasonable maximum exposure
USEPA - United States Environmental Protection Agency

Table D-95

Tier II RME Henry Site Radiological Risk Calculation for a Current/Future Seasonal Rancher

Medium	Radium-226 EPC[a]		Pathway-Specific Radium-226 PRG [b]		Pathway-Specific Radium-226 Risk	Total Medium Radium-226 Risk
Cattle						
Upland Soil	12.6	pCi/g	0.631	pCi/g	**2.0E-05**	**2.0E-05**
Upland Soil						
Incidental Ingestion	12.6	pCi/g	5.15	pCi/g	**2.4E-06**	**4.2E-04**
External Exposure	12.6	pCi/g	0.0304	pCi/g	**4.1E-04**	
Inhalation of Particulates	12.6	pCi/g	8,190	pCi/g	1.5E-09	
					Total Site Media Risk:	**4E-04**
					IDEQ Point-of-departure:	**10^{-5}**
					USEPA Risk Range:	**10^{-6} - 10^{-4}**

Notes:

[a] The upland soil EPC was calculated from gamma count measurements at the Henry Site according to the regression model described in the on-site and background areas radiological and soil investigation summary report (MWH, 2015).

[b] Preliminary Remediation Goals (PRGs) for radium-226+daughter products were calculated using the USEPA's online PRG calculator for radionuclides.

Bold indicates ILCR estimates above USEPA's risk management range or IDEQ's point of departure

EPC - Exposure point concentration
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
NA - not applicable
pCi/g - picocuries per gram
pCi/L - picocuries per liter
PRG - Preliminary Remediation Goal
RME - reasonable maximum exposure
USEPA - United States Environmental Protection Agency

Table D-95

Tier II RME Henry Site Radiological Risk Calculation for Current/Future Recreational Hunters

Medium	Radium-226 EPC[a]		Pathway-Specific Radium-226 PRG [b]		Pathway-Specific Radium-226 Risk	Total Medium Radium-226 Risk
Elk [c]						
Upland Soil	NA	pCi/g	30.2	pCi/g	NA	NA
Upland Soil						
Incidental Ingestion	12.6	pCi/g	44.2	pCi/g	2.8E-07	**9.7E-05**
External Exposure	12.6	pCi/g	0.130	pCi/g	**9.7E-05**	
Inhalation of Particulates	12.6	pCi/g	35,100	pCi/g	3.6E-10	
					Total Site Media Risk:	**1E-04**
					IDEQ Point-of-departure:	**10^{-5}**
					USEPA Risk Range:	**10^{-6} - 10^{-4}**

Notes:

[a] The upland soil EPC was calculated from gamma count measurements at the Henry Site according to the regression model described in the on-site and background areas radiological and soil investigation summary report (MWH, 2015).

[b] Preliminary Remediation Goals (PRGs) for radium-226+daughter products were calculated using the USEPA's online PRG calculator for radionuclides.

[c] Ingestion of elk was not evaluated in the Tier II HHRA because risks associated with this pathway in the Tier I HHRA did not exceed $1x10^{-6}$.

Bold indicates ILCR estimates above USEPA's risk management range or IDEQ's point of departure

EPC - Exposure point concentration
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
pCi/g - picocuries per gram
pCi/L - picocuries per liter
PRG - Preliminary Remediation Goal
RME - reasonable maximum exposure
USEPA - United States Environmental Protection Agency

Table D-97

Tier II RME Henry Site Radiological Risk Calculation for a Current/Future Recreational Camper / Hiker

Medium	Radium-226 EPC[a]		Pathway-Specific Radium-226 PRG [b]		Pathway-Specific Radium-226 Risk	Total Medium Radium-226 Risk
Upland Soil						
Incidental Ingestion	12.6	pCi/g	59.0	pCi/g	2.1E-07	**6.0E-05**
External Exposure	12.6	pCi/g	0.209	pCi/g	**6.0E-05**	
Inhalation of Particulates	12.6	pCi/g	62,500	pCi/g	2.0E-10	
					Total Site Media Risk:	**6E-05**
					IDEQ Point-of-departure:	**10^{-5}**
					USEPA Risk Range:	**10^{-6} - 10^{-4}**

Notes:

[a] The upland soil EPC was calculated from gamma count measurements at the Henry Site according to the regression model described in the on-site and background areas radiological and soil investigation summary report (MWH, 2015).

[b] Preliminary Remediation Goals (PRGs) for radium-226+daughter products were calculated using the USEPA's online PRG calculator for radionuclides.

Bold indicates ILCR estimates above USEPA's risk management range or IDEQ's point of departure

EPC - Exposure point concentration
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
pCi/g - picocuries per gram
PRG - Preliminary Remediation Goal
RME - reasonable maximum exposure
USEPA - United States Environmental Protection Agency

ATTACHMENT E – TIER II BACKGROUND HUMAN HEALTH RISK CALCULATIONS

Table E-1
Tier II RME Background Cancer Risk Calculation for a Current/Future Native American - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Dust Inhalation Dose (ug/m^3)	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b] Oral	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b] Dermal	URF (ug/m^3)$^{-1}$ [b] Inhalation	Pathway-Specific Cancer Risk Soil Ingestion	Pathway-Specific Cancer Risk Dermal	Pathway-Specific Cancer Risk Dust Inhalation	Chemical-Specific Risk
Arsenic	8.20	5.9E-06	4.3E-06	3.4E-08	1.5E+00	1.5E+00	4.3E-03	8.9E-06	6.5E-06	1.4E-10	**1.5E-05**
										ILCR	**2E-05**

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from background sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL percent upper confidence limit
ILCR incremental lifetime cancer risk
mg/kg milligrams per kilogram
mg/kg-d milligrams per kilogram per day
RME reasonable maximum exposure
URF unit risk factor
ug/m^3 microgram per cubic meter

Table E-2
Tier II RME Background Noncancer Hazard Calculation for a Current/Future Native American - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Dust Inhalation Dose (mg/m^3)	Reference Dose (mg/kg-d) [b]		RfC (mg/m^3) [b]	Pathway-Specific Hazard			Chemical-Specific HQ
					Oral	Dermal	Inhalation	Soil Ingestion	Dermal	Dust Inhalation	
Arsenic	8.20	1.4E-05	1.0E-05	7.8E-11	3.0E-04	3.0E-04	1.5E-05	4.6E-02	3.4E-02	5.2E-06	0.080
Uranium	10.2	2.9E-05	3.9E-06	9.7E-11	2.0E-04	2.0E-04	4.0E-05	1.4E-01	1.9E-02	2.4E-06	0.16
Vanadium	93.3	2.6E-04	3.6E-05	8.9E-10	5.0E-03	1.3E-04	1.0E-04	5.3E-02	2.8E-01	8.9E-06	0.33
										HI	0.6

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from background sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL	percent upper confidence limit	mg/m^3	milligram per cubic meter
HI	hazard index	RfC	reference concentration
HQ	hazard quotient	RME	reasonable maximum exposure
mg/kd-d	milligrams per kilogram per day		

Table E-3
Tier II RME Background Cancer Risk Calculation for a Hypothetical Future Resident - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Inhalation Dose (ug/m^3)	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b] Oral	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b] Dermal	URF (ug/m^3)$^{-1}$ [b] Inhalation	Pathway-Specific Cancer Risk Soil Ingestion	Pathway-Specific Cancer Risk Dermal	Pathway-Specific Cancer Risk Inhalation	Chemical-Specific Risk
Arsenic	8.20	5.9E-06	4.3E-06	3.4E-08	1.5E+00	1.5E+00	4.3E-03	8.9E-06	6.5E-06	1.4E-10	**1.5E-05**

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from background sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL	percent upper confidence limit
ILCR	incremental lifetime cancer risk
mg/kg	milligrams per kilogram
mg/kg-d	milligrams per kilogram per day
RME	reasonable maximum exposure
URF	unit risk factor
ug/m^3	microgram per cubic meter

Table E-4
Tier II RME Background Noncancer Hazard Calculation for a Hypothetical Future Resident - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Inhalation Dose (mg/m^3)	Reference Dose (mg/kg-d) [b]		RfC (mg/m^3) [b]	Pathway-Specific Hazard			Chemical-Specific HQ
					Oral	Dermal	Inhalation	Soil Ingestion	Dermal	Inhalation	
Arsenic	8.20	1.4E-05	1.0E-05	7.8E-11	3.0E-04	3.0E-04	1.5E-05	4.6E-02	3.4E-02	5.2E-06	0.080
Uranium	10.2	2.9E-05	3.9E-06	9.7E-11	2.0E-04	2.0E-04	4.0E-05	1.4E-01	1.9E-02	2.4E-06	0.16
Vanadium	93.3	2.6E-04	3.6E-05	8.9E-10	5.0E-03	1.3E-04	1.0E-04	5.3E-02	2.8E-01	8.9E-06	0.33
										HI	0.6

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from background sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL percent upper confidence limit
HI hazard index
HQ hazard quotient
mg/kg milligrams per kilogram
mg/kd-d milligrams per kilogram per day
mg/m^3 milligram per cubic meter
RfC reference concentration
RME reasonable maximum exposure

Table E-5
Tier II RME Background Cancer Risk Calculation for a Current/Future Seasonal Rancher - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Dust Inhalation Dose (ug/m^3)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Dermal	URF $(ug/m^3)^{-1}$ [b] Inhalation	Pathway-Specific Cancer Risk Soil Ingestion	Pathway-Specific Cancer Risk Dermal	Pathway-Specific Cancer Risk Dust Inhalation	Chemical-Specific Risk
Arsenic	8.20	7.9E-07	9.6E-07	7.2E-08	1.5E+00	1.5E+00	4.3E-03	1.2E-06	1.4E-06	3.1E-10	**2.6E-06**
										ILCR	**3E-06**

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from background sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL	percent upper confidence limit
ILCR	incremental lifetime cancer risk
mg/kg	milligrams per kilogram
mg/kg-d	milligrams per kilogram per day
RME	reasonable maximum exposure
URF	unit risk factor
ug/m^3	microgram per cubic meter

Table E-6
Tier II RME Background Noncancer Hazard Calculation for a Current/Future Seasonal Rancher - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Dust Inhalation Dose (mg/m^3)	Reference Dose (mg/kg-d) [b] Oral	Reference Dose (mg/kg-d) [b] Dermal	RfC (mg/m^3) [b] Inhalation	Pathway-Specific Hazard Soil Ingestion	Pathway-Specific Hazard Dermal	Pathway-Specific Hazard Dust Inhalation	Chemical-Specific HQ
Arsenic	8.20	2.3E-06	2.8E-06	2.1E-10	3.0E-04	3.0E-04	1.5E-05	7.7E-03	9.3E-03	1.4E-05	0.017
Uranium	10.2	4.8E-06	1.1E-06	2.6E-10	2.0E-04	2.0E-04	4.0E-05	2.4E-02	5.4E-03	6.5E-06	0.029
Vanadium	93.3	4.4E-05	9.9E-06	2.4E-09	5.0E-03	1.3E-04	1.0E-04	8.8E-03	7.6E-02	2.4E-05	0.085
										HI	0.1

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from background sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL	percent upper confidence limit	mg/m^3	milligram per cubic meter
HI	hazard index	RfC	reference concentration
HQ	hazard quotient	RME	reasonable maximum exposure
mg/kg	milligrams per kilogram		
mg/kd-d	milligrams per kilogram per day		

Table E-7
Tier II RME Background Cancer Risk Calculation for a Current/Future Hunter - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Dust Inhalation Dose (ug/m^3)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Dermal	URF $(ug/m^3)^{-1}$ [b] Inhalation	Pathway-Specific Cancer Risk Soil Ingestion	Pathway-Specific Cancer Risk Dermal	Pathway-Specific Cancer Risk Dust Inhalation	Chemical-Specific Risk
Arsenic	8.20	9.2E-08	8.4E-08	1.7E-08	1.5E+00	1.5E+00	4.3E-03	1.4E-07	1.3E-07	7.2E-11	2.6E-07
										ILCR	3E-07

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from background sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL	percent upper confidence limit
ILCR	incremental lifetime cancer risk
mg/kg	milligrams per kilogram
mg/kg-d	milligrams per kilogram per day
RME	reasonable maximum exposure
URF	unit risk factor
ug/m^3	microgram per cubic meter

Table E-8
Tier II RME Background Noncancer Hazard Calculation for a Current/Future Hunter - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Dust Inhalation Dose (mg/m^3)	Reference Dose (mg/kg-d) [b]		RfC (mg/m^3) [b]	Pathway-Specific Hazard			Chemical-Specific HQ
					Oral	Dermal	Inhalation	Soil Ingestion	Dermal	Dust Inhalation	
Arsenic	8.20	2.7E-07	2.4E-07	4.9E-11	3.0E-04	3.0E-04	1.5E-05	9.0E-04	8.1E-04	3.3E-06	0.0017
Uranium	10.2	5.6E-07	9.4E-08	6.0E-11	2.0E-04	2.0E-04	4.0E-05	2.8E-03	4.7E-04	1.5E-06	0.0033
Vanadium	93.3	5.1E-06	8.7E-07	5.5E-10	5.0E-03	1.3E-04	1.0E-04	1.0E-03	6.7E-03	5.5E-06	0.0077
										HI	0.01

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from background sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL	percent upper confidence limit
HI	hazard index
HQ	hazard quotient
mg/kg	milligrams per kilogram
mg/kd-d	milligrams per kilogram per day
mg/m^3	milligram per cubic meter
RfC	reference concentration
RME	reasonable maximum exposure

Table E-9
Tier II RME Background Cancer Risk Calculation for a Recreational Camper/Hiker - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Inhalation Dose (ug/m^3)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b]		URF $(ug/m^3)^{-1}$ [b]	Pathway-Specific Cancer Risk			Chemical-Specific Risk
					Oral	Dermal	Inhalation	Soil Ingestion	Dermal	Inhalation	
Arsenic	8.20	1.6E-07	1.0E-07	1.0E-08	1.5E+00	1.5E+00	4.3E-03	2.4E-07	1.6E-07	4.5E-11	4.0E-07

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from background sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL percent upper confidence limit
ILCR incremental lifetime cancer risk
mg/kg milligrams per kilogram
mg/kg-d milligrams per kilogram per day
RME reasonable maximum exposure
URF unit risk factor
ug/m^3 microgram per cubic meter

Table E-10
Tier II RME Background Noncancer Hazard Calculation for a Recreational Camper/Hiker - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Inhalation Dose (mg/m^3)	Reference Dose (mg/kg-d) [b] Oral	Reference Dose (mg/kg-d) [b] Dermal	RfC (mg/m^3) [b] Inhalation	Pathway-Specific Hazard Soil Ingestion	Pathway-Specific Hazard Dermal	Pathway-Specific Hazard Inhalation	Chemical-Specific HQ
Arsenic	8.20	3.7E-07	2.4E-07	2.4E-11	3.0E-04	3.0E-04	1.5E-05	1.2E-03	8.1E-04	1.6E-06	0.0021
Uranium	10.2	7.6E-07	9.5E-08	3.0E-11	2.0E-04	2.0E-04	4.0E-05	3.8E-03	4.7E-04	7.5E-07	0.0043
Vanadium	93.3	7.0E-06	8.7E-07	2.8E-10	5.0E-03	1.3E-04	1.0E-04	1.4E-03	6.7E-03	2.8E-06	0.0081
										HI	0.01

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from background sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL	percent upper confidence limit
HI	hazard index
HQ	hazard quotient
mg/kg	milligrams per kilogram
mg/kd-d	milligrams per kilogram per day
mg/m^3	milligram per cubic meter
RfC	reference concentration
RME	reasonable maximum exposure

Table E-11
Summary of Tier II RME Background Human Health Risk Estimates - Upland Soil

Analyte	Concentration[a] (mg/kg)			Current/Future Native American		Hypothetical Future Resident		Current/Future Seasonal Rancher		Current/Future Recreational Hunter		Current/Future Recreational Camper/Hiker	
	Maximum	95% UCL	EPC[b]	ILCR	HQ	ILCR	HQ	ILCR	HQ	ILCR	HQ	ILCR	HQ
Arsenic	19.0	8.20	8.20	**1.5E-05**	0.080	**1.5E-05**	0.080	**2.6E-06**	0.017	2.6E-07	0.0017	4.0E-07	0.0021
Uranium	42.0	10.2	10.2	NA	0.16	NA	0.16	NA	0.029	NA	0.0033	NA	0.0043
Vanadium	370	93.3	93.3	NA	0.33	NA	0.33	NA	0.085	NA	0.0077	NA	0.0081
Cumulative ILCR/HQ:				**2E-05**	0.6	**2E-05**	0.6	**3E-06**	0.1	3E-07	0.013	4E-07	0.01
IDEQ Point of Departure:				10^{-5}	1								
USEPA Risk Range:				10^{-6} - 10^{-4}	1								

Notes:

[a] Maximum detected concentration and ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from background sampling locations.

[b] The exposure point concentration (EPC) is the 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
NA - not applicable
USEPA - U. S. Environmental Protection Agency
RME - reasonable maximum exposure

Table E-12
Tier II Background Cancer Risk Calculation for a Current/Future Native American - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Soil Dermal Dose (mg/kg-d)	Dust Inhalation Dose (ug/m^3)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Dermal	URF $(ug/m^3)^{-1}$ [b] Inhalation	Pathway-Specific Cancer Risk Soil Ingestion	Pathway-Specific Cancer Risk Dermal	Pathway-Specific Cancer Risk Dust Inhalation	Chemical-Specific Risk
Arsenic	4.43	3.2E-06	2.3E-06	1.8E-08	1.5E+00	1.5E+00	4.3E-03	4.8E-06	3.5E-06	7.8E-11	**8.3E-06**
										ILCR	**8E-06**

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in riparian soil samples collected from background sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL	percent upper confidence limit	na	not available
ILCR	incremental lifetime cancer risk	URF	unit risk factor
mg/kg	milligrams per kilogram	ug/m^3	microgram per cubic meter
mg/kg-d	milligrams per kilogram per day		

Table E-13
Tier II Background Noncancer Hazard Calculation for a Current/Future Native American - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg)	Soil Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Dust Inhalation Dose (mg/m^3)	Reference Dose (mg/kg-d) [b] Oral	Reference Dose (mg/kg-d) [b] Dermal	RfC (mg/m^3) [b] Inhalation	Pathway-Specific Hazard Soil Ingestion	Pathway-Specific Hazard Dermal	Pathway-Specific Hazard Dust Inhalation	Chemical-Specific HQ
Arsenic	4.43	7.5E-06	5.4E-06	4.2E-11	3.0E-04	3.0E-04	1.5E-05	2.5E-02	1.8E-02	2.8E-06	0.043
Vanadium	37.0	1.0E-04	1.4E-05	3.5E-10	5.0E-03	1.3E-04	1.0E-04	2.1E-02	1.1E-01	3.5E-06	0.13
										HI	0.2

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in riparian soil samples collected from background sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL	percent upper confidence limit		milligrams per kilogram per day
HI	hazard index	mg/m^3	milligram per cubic meter
HQ	hazard quotient	na	not available
mg/kg	milligrams per kilogram	RfC	reference concentration
mg/kd-d	milligrams per kilogram per day		

Table E-14
Summary of Tier II Background Human Health Risk Estimates - Riparian Soil

Analyte	Concentration[a] (mg/kg)			Current/Future Native American		Recreational Fisher / Native American or Resident who Fishes [c]	
	Maximum	95% UCL	EPC[b]	ILCR	HQ	ILCR	HQ
Arsenic	5.44	4.43	4.43	**8.3E-06**	0.043	NA	NA
Vanadium	57.3	37.0	37.0	NA	0.13	NA	NA
Cumulative ILCR/HQ:				**8E-06**	0.2	NA	NA
IDEQ Point of Departure:				10^{-5}	1		
USEPA Risk Range:				10^{-6} - 10^{-4}	1		

Notes:

[a] Maximum detected concentration and ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in riparian soil samples collected from background sampling locations.

[b] The exposure point concentration (EPC) is the 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration.

[c] Riparian soil exposures associated with fishing were not evaluated in the Tier II risk assessment because risk and hazard estimates associated with this pathway in the Tier I risk assessment were not greater than the IDEQ point of departure or USEPA point of departure or risk range.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
NA - not applicable
USEPA - U. S. Environmental Protection Agency

Table E-15
Tier II RME Background Cancer Risk Calculation for a Current/Future Native American - Surface Water

Analyte	Surface Water Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b] Oral	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b] Dermal	Pathway-Specific Cancer Risk Ingestion	Pathway-Specific Cancer Risk Dermal	Chemical-Specific Risk
Arsenic	0.000735	6.6E-08	2.5E-08	1.5E+00	1.5E+00	1.0E-07	3.7E-08	1.4E-07
							ILCR	1E-07

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in surface water samples collected from background sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Cancer Risk = Exposure Dose x Cancer Slope Factor

% UCL	percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	RME	reasonable maximum exposure
mg/L	milligrams per liter		

Table E-16
Tier II RME Background Noncancer Hazard Calculation for a Current/Future Native American - Surface Water

Analyte	Surface Water Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b]		Pathway-Specific Hazard		Chemical-Specific HQ
				Oral	Dermal	Ingestion	Dermal	
Arsenic	0.000735	1.6E-07	5.7E-08	3.0E-04	3.0E-04	5.2E-04	1.9E-04	0.00071
							HI	0.0007

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in surface water samples collected from background sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula: Noncancer HQ = Exposure Dose/Reference dose

% UCL	percent upper confidence limit	mg/kg	milligrams per kilogram
HI	hazard index	mg/kd-d	milligrams per kilogram per day
HQ	hazard quotient	RME	reasonable maximum exposure

Table E-17
Summary of Tier II RME Background Human Health Risk Estimates - Surface Water

Analyte	Concentration[a] (mg/L)			Current/Future Native American		Current/Future Recreational Fisher / Hypothetical Future Resident who Fishes [c]	
	Maximum	95% UCL	EPC[b]	ILCR	HQ	ILCR	HQ
Arsenic	0.00110	0.000735	0.000735	1.4E-07	0.00071	NA	NA
Cumulative ILCR/HQ				1E-07	0.0007	NA	NA
IDEQ Point of Departure:				10^{-5}	1		
USEPA Risk Range:				10^{-6} - 10^{-4}	1		

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in surface water samples collected from background sampling locations.

[b] The exposure point concentration (EPC) is the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration.

[c] Surface water exposures associated with a current/future recreational fisher or hypothetical future resident who fishes were not evaluated in the Tier II risk assessment because risk and hazard estimates associated with this pathway in the Tier I risk assessment were not greater than the IDEQ point of departure or USEPA point of departure or risk range.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/L - milligrams per liter
NA - not applicable
USEPA - U. S. Environmental Protection Agency
RME - reasonable maximum exposure

Table E-18
Tier II Background Cancer Risk Calculation for a Hypothetical Future Resident - Groundwater

Analyte	Groundwater Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Concentration (ug/m^3)	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b] Oral	Cancer Slope Factor (mg/kg-d)$^{-1}$ [b] Dermal	URF (ug/m^3)$^{-1}$ [b] Inhalation	Pathway-Specific Cancer Risk Ingestion	Pathway-Specific Cancer Risk Dermal	Pathway-Specific Cancer Risk Inhalation	Chemical-Specific Risk
Arsenic	0.000723	1.3E-05	7.4E-08	NA	1.5E+00	1.5E+00	4.3E-03	1.9E-05	1.1E-07	NA	**1.9E-05**
										ILCR	**2E-05**

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in groundwater samples collected from background sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula:
Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL	percent upper confidence limit	NA	not applicable
ILCR	incremental lifetime cancer risk	URF	unit risk factor
mg/L	milligrams per liter	ug/m^3	microgram per cubic meter
mg/kg-d	milligrams per kilogram per day		

Table E-19
Tier II Background Noncancer Hazard Calculation for a Hypothetical Future Resident - Groundwater

Analyte	Groundwater Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Concentration (mg/m^3)	Reference Dose (mg/kg-d) [b]		RfC (mg/m^3) [b]	Pathway-Specific Hazard			Chemical-Specific HQ
					Oral	Dermal	Inhalation	Ingestion	Dermal	Inhalation	
Arsenic	0.000723	3.0E-05	1.7E-07	NA	3.0E-04	3.0E-04	1.5E-05	9.9E-02	5.7E-04	NA	0.10
Cobalt	0.000436	1.8E-05	4.1E-08	NA	3.0E-04	3.0E-04	6.0E-06	6.0E-02	1.4E-04	NA	0.060
Manganese	0.189	7.8E-03	4.5E-05	NA	1.4E-01	5.6E-03	5.0E-05	5.5E-02	8.0E-03	NA	0.063
Selenium	0.00124	5.1E-05	2.9E-07	NA	5.0E-03	1.5E-03	2.0E-02	1.0E-02	2.0E-04	NA	0.010
Thallium	0.000200	8.2E-06	4.7E-08	NA	1.0E-05	1.0E-05	na	8.2E-01	4.7E-03	NA	0.83
										HI	1

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in groundwater samples collected from background sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula:
Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL	percent upper confidence limit	mg/m^3	milligram per cubic meter
HI	hazard index	NA	not applicable
HQ	hazard quotient	na	not available
mg/kg	milligrams per kilogram	RfC	reference concentration
mg/kd-d	milligrams per kilogram per day		

Table E-20
Tier II Background Cancer Risk Calculation for a Current/Future Seasonal Rancher - Groundwater

Analyte	Groundwater Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Concentration (ug/m^3)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Dermal	URF $(ug/m^3)^{-1}$ [b] Inhalation	Pathway-Specific Cancer Risk Ingestion	Pathway-Specific Cancer Risk Dermal	Pathway-Specific Cancer Risk Inhalation	Chemical-Specific Risk
Arsenic	0.000723	2.3E-06	1.6E-08	NA	1.5E+00	1.5E+00	4.3E-03	3.5E-06	2.4E-08	NA	**3.5E-06**
										ILCR	**4E-06**

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in groundwater samples collected from background sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

1) Cancer risks are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula:
Cancer Risk = Exposure Dose x Cancer Slope Factor or Cancer Risk = Exposure Concentration x Unit Risk Factor

% UCL	percent upper confidence limit	NA	not applicable
ILCR	incremental lifetime cancer risk	URF	unit risk factor
mg/L	milligrams per liter	ug/m^3	microgram per cubic meter
mg/kg-d	milligrams per kilogram per day		

Table E-21
Tier II Background Noncancer Hazard Calculation for a Current/Future Seasonal Rancher - Groundwater

Analyte	Groundwater Concentration[a] (mg/L)	Ingestion Dose (mg/kg-d)	Dermal Dose (mg/kg-d)	VOC Inhalation Concentration (mg/m^3)	Reference Dose (mg/kg-d) [b] Oral	Reference Dose (mg/kg-d) [b] Dermal	RfC (mg/m^3) [b] Inhalation	Pathway-Specific Hazard Ingestion	Pathway-Specific Hazard Dermal	Pathway-Specific Hazard Inhalation	Chemical-Specific HQ
Arsenic	0.000723	2.8E-07	4.7E-08	NA	3.0E-04	3.0E-04	1.5E-05	9.4E-04	1.6E-04	NA	0.0011
Cobalt	0.000436	1.7E-07	1.1E-08	NA	3.0E-04	3.0E-04	6.0E-06	5.7E-04	3.7E-05	NA	0.00061
Manganese	0.189	7.4E-05	1.2E-05	NA	1.4E-01	5.6E-03	5.0E-05	5.3E-04	2.2E-03	NA	0.0027
Selenium	0.00124	4.9E-07	8.0E-08	NA	5.0E-03	1.5E-03	2.0E-02	9.7E-05	5.3E-05	NA	0.00015
Thallium	0.000200	7.8E-08	1.3E-08	NA	1.0E-05	1.0E-05	na	7.8E-03	1.3E-03	NA	0.0091
										HI	0.01

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in groundwater samples collected from background sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

1) Noncancer hazards are unitless values which represent the probability of incurring an adverse health effect. They are calculated using the following formula:
Noncancer HQ = Exposure Dose/Reference dose or Exposure Concentration/Reference Concentration

% UCL	percent upper confidence limit	mg/m^3	milligram per cubic meter
HI	hazard index	NA	not applicable
HQ	hazard quotient	na	not available
mg/kg	milligrams per kilogram	RfC	reference concentration
mg/kd-d	milligrams per kilogram per day		

Table E-22
Summary of Tier II Background Human Health Risk Estimates - Groundwater

Analyte	Concentration[a] (mg/L)			Hypothetical Future Resident		Current/Future Seasonal Rancher	
	Maximum	95% UCL	EPC[b]	ILCR	HQ	ILCR	HQ
Arsenic	0.000989	0.000723	0.000723	**1.9E-05**	0.10	**3.5E-06**	0.0011
Cobalt	0.000436	NC	0.000436	NA	0.060	NA	0.00061
Manganese	0.456	0.189	0.189	NA	0.063	NA	0.0027
Selenium	0.00267	0.00124	0.00124	NA	0.010	NA	0.00015
Thallium	0.000200	NC	0.000200	NA	0.83	NA	0.0091
Cumulative ILCR/HQ				**2E-05**	1	**4E-06**	0.01
IDEQ Point of Departure:				10^{-5}	1	10^{-5}	1
USEPA Risk Range:				10^{-6} - 10^{-4}	1	10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in groundwater samples collected from background sampling locations.

[b] The exposure point concentration (EPC) is the or ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/L - milligrams per liter
NA - not applicable
NC - not calculated
USEPA - U. S. Environmental Protection Agency

Table E-23
Tier II Background Cancer Risk Calculation for a Current/Future Native American - Culturally Significant Plants - Upland Soi

Analyte	Upland Soil Concentration[a] (mg/kg)	Modeled Culturally Significant Plant Concentration from Soil (mg/kg)	Measured Culturally Significant Plants Concentration (mg/kg)	Modeled Plant Ingestion Dose (mg/kg-d)	Measured Plant Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Pathway-Specific Cancer Risk: Modeled Plant Ingestion	Pathway-Specific Cancer Risk: Measured Plant Ingestion	Chemical-Specific Risk [c]
Arsenic	8.20	0.193	na	4.3E-04	na	1.5E+00	6.5E-04	na	**6.5E-04**
								ILCR	**6E-04**

Notes:

[a] The ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured or the maximum detected concentration in upland soil samples collected from background sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

[c] Where available, measured plant concentrations were used preferentially over modeled plant concentrations to calculate risk.

% UCL	percent upper confidence limit
ILCR	incremental lifetime cancer risk
mg/kg	milligrams per kilogram
mg/kg-d	milligrams per kilogram per day
na	not available

Table E-24
Tier II Background Noncancer Hazard Calculation for a Current/Future Native American - Culturally Significant Plants - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)	Modeled Culturally Significant Plant Concentration from Soil (mg/kg)	Measured Culturally Significant Plants Concentration (mg/kg)	Modeled Plant Ingestion Dose (mg/kg-d)	Measured Plant Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Pathway-Specific Hazard Modeled Plant Ingestion	Pathway-Specific Hazard Measured Plant Ingestion	Chemical-Specific HQ [c]
Antimony	1.04	0.0662	2.93	3.4E-04	1.5E-02	4.0E-04	0.86	38	**38**
Arsenic	8.20	0.193	na	1.0E-03	na	3.0E-04	3.3	na	**3.3**
Cadmium	13.6	1.89	na	9.8E-03	na	1.0E-03	9.8	na	**9.8**
Cobalt	7.92	0.147	na	7.6E-04	na	3.0E-04	2.5	na	**2.5**
Selenium	6.67	0.132	0.168	6.9E-04	8.7E-04	5.0E-03	0.14	0.17	0.17
Thallium	0.510	0.00741	0.00398	3.9E-05	2.1E-05	1.0E-05	3.9	2.1	**2.1**
								HI	**56**

Notes:

[a] The ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured or the maximum detected concentration in upland soil samples collected from background sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

[c] Where available, measured plant concentrations were used preferentially over modeled plant concentrations to calculate an HQ.

% UCL	percent upper confidence limit	mg/kg	milligrams per kilogram
HI	hazard index	mg/kd-d	milligrams per kilogram per day
HQ	hazard quotient	na	not available

Table E-25
Summary of Tier II Background Human Health Risk Estimates - Culturally Significant Plants - Upland Soil

Analyte	Upland Soil Concentration[a] (mg/kg)			Modeled Culturally Significant Plants Concentration (mg/kg)	Measured Culturally Significant Plants Concentration (mg/kg)	Current/Future Native American	
	Maximum	95% UCL	EPC[b]	EPC[c]	EPC[d]	ILCR	HQ
Antimony	3.60	1.04	1.04	0.0662	2.93	NA	**38**
Arsenic	19.0	8.20	8.20	0.193	na	**6.5E-04**	**3.3**
Cadmium	44.0	13.6	13.6	1.89	na	NA	**9.8**
Cobalt	13.3	7.92	7.92	0.147	na	NA	**2.5**
Selenium	29.0	6.67	6.67	0.132	0.168	NA	0.17
Thallium	1.30	0.510	0.510	0.00741	0.00398	NA	**2.1**
					Cumulative ILCR/HQ:	**6E-04**	**56**
					IDEQ Point of Departure:	10^{-5}	1
					USEPA Risk Range:	10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration and ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil samples collected from background sampling locations.

[b] The ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured or the maximum detected concentration in upland soil samples collected from background sampling locations.

[c] The culturally significant plants EPC was modeled from the upland soil EPC using soil-to-plant uptake factors.

[d] The ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration the maximum detected concentration measured in culturally significant plants samples in wet weight. The dry weight culturally significant plants data were converted to wet weight using an average moisture content of 66 percent.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk

mg/kg - milligrams per kilogarm
NA - not applicable
na - not available
USEPA - U. S. Environmental Protection Agency

Table E-26
Tier II Background Cancer Risk Calculation for a Current/Future Native American - Culturally Significant Plants - Riparian Soi

Analyte	Riparian Soil Concentration[a] (mg/kg)	Modeled Culturally Significant Plant Concentration from Soil (mg/kg)	Measured Riparian Plant Concentration (mg/kg)	Modeled Plant Ingestion Dose (mg/kg-d)	Measured Plant Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Pathway-Specific Cancer Risk: Modeled Plant Ingestion	Pathway-Specific Cancer Risk: Measured Plant Ingestion	Chemical-Specific Risk [c]
Arsenic	4.43	0.104	na	2.3E-04	na	1.5E+00	3.5E-04	na	**3.5E-04**
								ILCR	**3E-04**

Notes:

[a] The exposure point concentration (EPC) is the 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

[c] Where available, measured plant concentrations were used preferentially over modeled plant concentrations to calculate risk.

% UCL	percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	na	not available
mg/kg	milligrams per kilogram		

Table E-27
Tier II Background Noncancer Hazard Calculation for a Current/Future Native American - Culturally Significant Plants - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg)	Modeled Culturally Significant Plant Concentration from Soil (mg/kg)	Measured Riparian Plant Concentration (mg/kg)	Modeled Plant Ingestion Dose (mg/kg-d)	Measured Plant Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d)[b] Oral	Pathway-Specific Hazard: Modeled Plant Ingestion	Pathway-Specific Hazard: Measured Plant Ingestion	Chemical-Specific HQ[c]
Antimony	5.50	0.349	na	1.8E-03	na	4.0E-04	4.5E+00	na	**4.5**
Arsenic	4.43	0.104	na	5.4E-04	na	3.0E-04	1.8E+00	na	**1.8**
Cadmium	2.81	0.389	0.188	2.0E-03	9.8E-04	1.0E-03	2.0E+00	9.8E-01	0.98
Cobalt	8.25	0.153	na	8.0E-04	na	3.0E-04	2.7E+00	na	**2.7**
Manganese	655	49.8	na	2.6E-01	na	1.4E-01	1.8E+00	na	**1.8**
Nickel	20.2	0.576	na	3.0E-03	na	2.0E-02	1.5E-01	na	0.15
Selenium	1.12	0.0221	0.272	1.2E-04	1.4E-03	5.0E-03	2.3E-02	2.8E-01	0.28
Thallium	0.333	0.00484	na	2.5E-05	na	1.0E-05	2.5E+00	na	**2.5**
Vanadium	37.0	0.551	na	2.9E-03	na	5.0E-03	5.7E-01	na	0.57
								HI	**15**

Notes:
[a] The exposure point concentration (EPC) is the 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration.
[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.
[c] Where available, measured plant concentrations were used preferentially over modeled plant concentrations to calculate an HQ.

HI	hazard index	mg/kd-d	milligrams per kilogram per day
HQ	hazard quotient	na	not available
mg/kg	milligrams per kilogram		

Table E-28
Summary of Tier II Background Human Health Risk Estimates - Culturally Significant Plants - Riparian Soil

Analyte	Riparian Soil Concentration[a] (mg/kg)			Modeled Culturally Significant Plants Concentration (mg/kg)	Measured Riparian Plants Concentration (mg/kg)	Current/Future Native American	
	Maximum	95% UCL	EPC[b]	EPC[c]	EPC[d]	ILCR	HQ
Antimony	5.50	NC	5.50	0.349	na	NA	**4.5**
Arsenic	5.44	4.43	4.43	0.104	na	**3.5E-04**	**1.8**
Cadmium	4.40	2.81	2.81	0.389	0.188	NA	0.98
Cobalt	10.1	8.25	8.25	0.153	na	NA	**2.7**
Manganese	1,080	655	655	49.8	na	NA	**1.8**
Nickel	26.6	20.2	20.2	0.576	na	NA	0.15
Selenium	1.80	1.12	1.12	0.0221	0.272	NA	0.28
Thallium	0.428	0.333	0.333	0.00484	na	NA	**2.5**
Vanadium	57.3	37.0	37.0	0.551	na	NA	0.57
					Cumulative ILCR/HQ:	**3E-04**	**15**
					IDEQ Point of Departure:	10^{-5}	1
					USEPA Risk Range:	10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration and ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in riparian soil samples collected from background sampling locations.

[b] The exposure point concentration (EPC) is the 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration.

[c] The culturally significant plants EPC was modeled from the riparian soil EPC using soil-to-plant uptake factors.

[d] The ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration measured in culturally significant plants samples in wet weight. The dry weight culturally significant plants data were converted to wet weight using an average moisture content of 66 percent.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
NA - not applicable
na - not available
USEPA - U. S. Environmental Protection Agency

Table E-29
Tier II Background Cancer Risk Calculation for a Hypothetical Future Resident - Fruits and Vegetables - Upland Soil and Groundwater

Analyte	Upland Soil Concentration[a] (mg/kg)	Groundwater Concentration[a] (mg/L)	Modeled Fruits and Vegetables Concentration from Soil (mg/kg)	Modeled Fruits and Vegetables Concentration from Groundwater (mg/kg)	Measured Non-Culturally Significant Plants Concentration (mg/kg)	Total Fruits and Vegetables Concentration [b] (mg/kg)	Plant Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [c] Oral	Chemical-Specific Risk
Arsenic	8.20	0.000723	0.193	0.00324	na	0.196	4.4E-04	1.5E+00	**6.6E-04**
								ILCR	**7E-04**

Notes:

[a] The ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration measured in upland soil and groundwater samples collected from background sampling locations.

[b] For an analyte that is only a constituent of potential concern (COPC) in soil, measured non-culturally significant plant concentration, when available, was used to represent the fruits and vegetables concentration. If an analyte is a COPC in groundwater, the total fruits and vegetables concentration is equal to the modeled concentration from groundwater plus either the measured non-culturally significant plant concentration when available, or the modeled concentration from soil.

[c] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/L	milligrams per liter
ILCR	incremental lifetime cancer risk	na	not available
mg/kg	milligrams per kilogram		
mg/kd-d	milligrams per kilogram per day		

Table E-30
Tier II Background Noncancer Hazard Calculation for a Hypothetical Future Resident - Fruits and Vegetables - Upland Soil and Groundwater

Analyte	Upland Soil Concentration[a] (mg/kg)	Groundwater Concentration[a] (mg/L)	Modeled Fruits and Vegetables Concentration from Soil (mg/kg)	Modeled Fruits and Vegetables Concentration from Groundwater (mg/kg)	Measured Non-Culturally Significant Plants Concentration (mg/kg)	Total Fruits and Vegetables Concentration [b] (mg/kg)	Plant Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [c] Oral	Chemical-Specific HQ
Antimony	1.04	NA	0.0662	NA	1.84	1.84	9.6E-03	4.0E-04	**24**
Arsenic	8.20	0.000723	0.193	0.00324	na	0.196	1.0E-03	3.0E-04	**3.4**
Cadmium	13.6	NA	1.89	NA	0.139	0.139	7.3E-04	1.0E-03	0.73
Cobalt	7.92	0.000436	0.147	0.00188	na	0.148	7.7E-04	3.0E-04	**2.6**
Manganese	1,423	0.189	108	1.20	na	109	5.7E-01	1.4E-01	**4.1**
Molybdenum	NA	0.0239	NA	0.152	0.872	1.02	5.3E-03	5.0E-03	**1.1**
Nickel	69.8	NA	1.99	NA	na	1.99	1.0E-02	2.0E-02	0.52
Selenium	6.67	0.00124	0.132	0.00539	0.313	0.318	1.7E-03	5.0E-03	0.33
Thallium	0.510	0.000200	0.00741	0.000832	0.00398	0.00481	2.5E-05	1.0E-05	**2.5**
Uranium	10.2	NA	0.159	NA	0.0367	0.0367	1.9E-04	2.0E-04	0.96
Vanadium	93.3	NA	1.39	NA	na	1.39	7.2E-03	5.0E-03	**1.4**
								HI	**42**

Notes:

[a] The ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration measured in upland soil and groundwater samples collected from background sampling locations.

[b] For an analyte that is only a constituent of potential concern (COPC) in soil, measured non-culturally significant plant concentration, when available, was used to represent the fruits and vegetables concentration. If an analyte is a COPC in groundwater, the total fruits and vegetables concentration is equal to the modeled concentration from groundwater plus either the measured non-culturally significant plant concentration when available, or the modeled concentration from soil.

[c] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kg	milligrams per kilogram	na	not available
HI	hazard index	mg/kd-d	milligrams per kilogram per day	NA	not applicable
HQ	hazard quotient	mg/L	milligrams per liter		

Table E-31

Summary of Tier II Background Human Health Risk Estimates - Fruits and Vegetables - Upland Soil and Groundwater

Analyte	Upland Soil Concentration[a] (mg/kg)			Groundwater Concentration[a] (mg/L)			Modeled Total Fruits and Vegetables Concentration (mg/kg)	Measured Non-Culturally Significant Plants Concentration (mg/kg)	Hypothetical Future Resident	
	Maximum	95% UCL	EPC[b]	Maximum	95% UCL	EPC[c]	EPC[d]	EPC[e]	ILCR	HQ
Antimony	3.60	1.04	1.04	NA	NA	NA	1.84	1.84	NA	**24**
Arsenic	19.0	8.20	8.20	0.000989	0.000723	0.000723	0.196	na	**6.6E-04**	**3.4**
Cadmium	44.0	13.6	13.6	NA	NA	NA	0.139	0.139	NA	0.73
Cobalt	13.3	7.92	7.92	0.000436	NC	0.000436	0.148	na	NA	**2.6**
Manganese	3,990	1,423	1,423	0.456	0.189	0.189	109	na	NA	**4.1**
Molybdenum	NA	NA	NA	0.0239	NC	0.0239	1.02	0.872	NA	**1.1**
Nickel	230	69.8	69.8	NA	NA	NA	1.99	na	NA	0.52
Selenium	29.0	6.67	6.67	0.00267	0.00124	0.00124	0.318	0.313	NA	0.33
Thallium	1.30	0.510	0.510	0.000200	NC	0.000200	0.00481	0.00398	NA	**2.5**
Uranium	42.0	10.2	10.2	NA	NA	NA	0.0367	0.0367	NA	0.96
Vanadium	370	93.3	93.3	NA	NA	NA	1.39	na	NA	**1.4**
								Cumulative ILCR/HQ:	**7E-04**	**42**
								IDEQ Point of Departure:	10^{-5}	1
								USEPA Risk Range:	10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration and ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil and groundwater samples collected from background sampling locations.

[b] The soil EPC used to model fruits and vegetables concentration is the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration.

[c] The groundwater EPC used to model fruits and vegetables concentration is the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration.

[d] The fruits and vegetables EPC was modeled from the groundwater EPC and the measured plant EPC, where available, or the soil EPC, using plant uptake factors as described in Table E-29 and Table E-30.

[e] The ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration measured in non-culturally significant plant samples in wet weight. The dry weight non-culturally significant data were converted to wet weight using an average moisture content of 66 percent.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
mg/L - milligrams per liter
NA - not applicable
na - not available
NC - not calculated
USEPA - U. S. Environmental Protection Agency

Table E-32
Tier II Background Cancer Risk Calculation for a Current/Future Seasonal Rancher - Cattle - Upland Soil and Surface Water

Analyte	Upland Soil Concentration[a] (mg/kg)	Surface Water Concentration (mg/L)	Modeled Cattle Concentration from Soil (mg/kg)	Modeled Cattle Concentration from Surface Water (mg/kg)	Total Cattle Concentration (mg/kg)	Modeled Cattle Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Chemical-Specific Risk
Arsenic	8.20	0.000735	0.00464	0.0000779	0.00472	1.1E-05	1.5E+00	**1.6E-05**
							ILCR	**2E-05**

Notes:

[a] Maximum detected concentration or the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil and surface water samples collected from background sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	mg/L	milligrams per liter
mg/kg	milligrams per kilogram		

Table E-33
Tier II Background Noncancer Hazard Calculation for a Current/Future Seasonal Rancher - Cattle - Upland Soil and Surface Water

Analyte	Upland Soil Concentration[a] (mg/kg)	Surface Water Concentration[a] (mg/L)	Modeled Cattle Concentration from Soil (mg/kg)	Modeled Cattle Concentration from Surface Water (mg/kg)	Total Cattle Concentration (mg/kg)	Modeled Cattle Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Chemical-Specific HQ
Arsenic	8.20	0.000735	0.00464	0.0000779	0.00472	3.1E-05	3.0E-04	0.10
Cobalt	7.92	0.0100	0.0326	0.0106	0.0432	2.8E-04	3.0E-04	0.94
Selenium	6.67	0.000579	0.0225	0.000460	0.0230	1.5E-04	5.0E-03	0.030
Thallium	0.510	0.000150	0.00293	0.000318	0.00325	2.1E-05	1.0E-05	**2.1**
							HI	**3**

Notes:

[a] Maximum detected concentration or the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil and surface water samples collected from background sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	mg/L	milligrams per liter
HQ	hazard quotient	NA	not applicable
mg/kg	milligrams per kilogram		

Table E-34
Summary of Tier II Background Human Health Risk Estimates - Cattle - Upland Soil and Surface Water

Analyte	Upland Soil Concentration[a] (mg/kg)			Surface Water Concentration[a] (mg/L)			Modeled Cattle Concentration (mg/kg)	Current/Future Seasonal Rancher	
	Maximum	95% UCL	EPC[b]	Maximum	95% UCL	EPC[b]	EPC[c]	ILCR	HQ
Arsenic	19.0	8.20	8.20	0.00110	0.000735	0.000735	0.00472	**1.6E-05**	0.10
Cobalt	13.3	7.92	7.92	ND	0.0100	0.0100	0.0432	NA	0.94
Selenium	29.0	6.67	6.67	0.00100	0.000579	0.000579	0.0230	NA	0.030
Thallium	1.30	0.510	0.510	0.000150	NC	0.000150	0.00325	NA	**2.1**
Cumulative ILCR/HQ:								**2E-05**	**3**
IDEQ Point of Departure:								10^{-5}	1
USEPA Risk Range:								10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration and ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil and surface water samples collected from background sampling locations.

[b] The upland soil and surface water EPCs used to model cattle concentration are the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration in those media.

[c] The cattle EPC was modeled from upland soil and surface water EPCs.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk
mg/kg - milligrams per kilogarm
mg/L - milligrams per liter
NA - not applicable
NC - not calculated
ND - not detected
USEPA - U. S. Environmental Protection Agency

Table E-35
Tier II Background Cancer Risk Calculation for a Current/Future Seasonal Rancher - Cattle - Upland Soil and Groundwater

Analyte	Upland Soil Concentration[a] (mg/kg)	Groundwater Concentration (mg/L)	Modeled Cattle Concentration from Soil (mg/kg)	Modeled Cattle Concentration from Groundwater (mg/kg)	Total Cattle Concentration (mg/kg)	Modeled Cattle Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Chemical-Specific Risk
Arsenic	8.20	0.000723	0.00464	0.0000766	0.00472	1.1E-05	1.5E+00	**1.6E-05**
							ILCR	**2E-05**

Notes:

[a] Maximum detected concentration or the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil and groundwater samples collected from background sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

% UCL — percent upper confidence limit
ILCR — incremental lifetime cancer risk
mg/kg — milligrams per kilogram
mg/kg-d — milligrams per kilogram per day
mg/L — milligrams per liter

Table E-36
Tier II Background Noncancer Hazard Calculation for a Current/Future Seasonal Rancher - Cattle - Upland Soil and Groundwater

Analyte	Upland Soil Concentration[a] (mg/kg)	Groundwater Concentration[a] (mg/L)	Modeled Cattle Concentration from Soil (mg/kg)	Modeled Cattle Concentration from Groundwater (mg/kg)	Total Cattle Concentration (mg/kg)	Modeled Cattle Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Chemical-Specific HQ
Arsenic	8.20	0.000723	0.00464	0.0000766	0.00472	3.1E-05	3.0E-04	0.10
Cobalt	7.92	0.000436	0.0326	0.000462	0.0330	2.2E-04	3.0E-04	0.72
Selenium	6.67	0.00124	0.0225	0.000986	0.0235	1.5E-04	5.0E-03	0.031
Thallium	0.510	0.000200	0.00293	0.000424	0.00336	2.2E-05	1.0E-05	**2.2**
							HI	**3**

Notes:

[a] Maximum detected concentration or the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil and groundwater samples collected from background sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

% UCL	percent upper confidence limit	mg/kd	milligrams per kilogram
HI	hazard index	mg/kd-d	milligrams per kilogram per day
HQ	hazard quotient	mg/L	milligrams per liter

Table E-37
Summary of Tier II Background Human Health Risk Estimates - Cattle - Upland Soil and Groundwater

Analyte	Upland Soil Concentration[a] (mg/kg)			Groundwater Concentration[a] (mg/L)			Modeled Cattle Concentration (mg/kg)	Current/Future Seasonal Rancher	
	Maximum	95% UCL	EPC[b]	Maximum	95% UCL	EPC[b]	EPC[c]	ILCR	HQ
Arsenic	19.0	8.20	8.20	0.000989	0.000723	0.000723	0.00472	**1.6E-05**	0.10
Cobalt	13.3	7.92	7.92	0.000436	NC	0.000436	0.0330	NA	0.72
Selenium	29.0	6.67	6.67	0.00267	0.00124	0.00124	0.0235	NA	0.031
Thallium	1.30	0.510	0.510	0.000200	NC	0.000200	0.00336	NA	**2.2**
							Cumulative ILCR/HQ:	**2E-05**	**3**
							IDEQ Point of Departure:	10^{-5}	1
							USEPA Risk Range:	10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration and ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in upland soil and groundwater samples collected from background sampling locations.

[b] The upland soil and groundwater EPCs used to model cattle concentrations are the ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration or the maximum detected concentration in those media.

[c] The cattle EPC was modeled from upland soil and groundwater EPCs.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk

mg/kg - milligrams per kilogarm
mg/L - milligrams per liter
NA - not applicable
NC - not calculated
USEPA - U. S. Environmental Protection Agency

Table E-38
Tier II Background Cancer Risk Calculation for a Current/Future Native American - Culturally Significant Aquatic Plants

Analyte	Sediment Concentration[a] (mg/kg)	Surface Water Concentration[a] (mg/L)	Modeled Culturally Significant Aquatic Plant Concentration from Sediment (mg/kg dry weight)	Modeled Culturally Significant Aquatic Plant Concentration from Sediment [b] (mg/kg wet weight)	Modeled Plant Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [c] Oral	Chemical-Specific Risk
Arsenic	4.55	0.000735	0.171	0.0585	1.3E-04	1.5E+00	**2.0E-04**
						ILCR	**2E-04**

Notes:

[a] Maximum detected concentration or 95% UCL on the mean concentration measured in sediment or surface water samples collected from background sampling locations.

[b] Dry weight plant concentrations were converted to wet weight plant concentrations assuming a plant moisture content of 65.7 percent.

[c] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

95% UCL	95 percent upper confidence limit
ILCR	incremental lifetime cancer risk
mg/kg	milligrams per kilogram
mg/kg-d	milligrams per kilogram per day
mg/L	milligrams per liter

Table E-39
Tier II Background Noncancer Hazard Calculation for a Current/Future Native American - Culturally Significant Aquatic Plants

Analyte	Sediment Concentration[a] (mg/kg)	Surface Water Concentration (mg/L)	Modeled Culturally Significant Aquatic Plant Concentration from Sediment (mg/kg dry weight)	Modeled Culturally Significant Aquatic Plant Concentration from Sediment [b] (mg/kg wet weight)	Modeled Plant Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [c] Oral	Chemical-Specific HQ
Antimony	5.00	NA	0.178	0.0611	3.2E-04	4.0E-04	0.80
Arsenic	4.55	0.00073	0.171	0.0585	3.0E-04	3.0E-04	1.0
Cadmium	2.29	0.000100	0.979	0.335	1.7E-03	1.0E-03	**1.7**
Manganese	405	0.0238	32.0	11.0	5.7E-02	1.4E-01	0.41
Nickel	19.7	0.00129	1.01	0.345	1.8E-03	2.0E-02	0.090
Selenium	1.01	0.000579	0.514	0.176	9.2E-04	5.0E-03	0.18
Thallium	0.378	0.000150	0.00151	0.000518	2.7E-06	1.0E-05	0.27
Uranium	2.37	0.000529	0.0201	0.00690	3.6E-05	2.0E-04	0.18
Vanadium	33.0	0.00140	0.160	0.0548	2.9E-04	5.0E-03	0.057
Zinc	107	0.00525	64.3	22.0	1.1E-01	3.0E-01	0.38
						HI	**5**

Notes:

[a] Maximum detected concentration or 95% UCL on the mean concentration measured in sediment or surface water samples collected from background sampling locations.

[b] Dry weight plant concentrations were converted to wet weight plant concentrations assuming a plant moisture content of 65.7 percent.

[c] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

95% UCL	95 percent upper confidence limit	mg/kd-d	milligrams per kilogram per day
HI	hazard index	mg/L	milligrams per liter
HQ	hazard quotient	NA	not applicable
mg/kg	milligrams per kilogram		

Table E-40
Summary of Tier II Background Human Health Risk Estimates - Culturally Significant Aquatic Plants

Analyte	Sediment Concentration[a] (mg/kg)			Surface Water Concentration[a] (mg/L)			Modeled Culturally Significant Aquatic Plants Concentration (mg/kg)	Current/Future Native American	
	Maximum	95% UCL	EPC[b]	Maximum	95% UCL	EPC	EPC[c]	ILCR	HQ
Antimony	5.00	NC	5.00	NA	NA	NA	0.0611	NA	0.80
Arsenic	4.55	NC	4.55	0.00110	0.000735	0.000735	0.0585	**2.0E-04**	1.0
Cadmium	3.74	2.29	2.29	0.000100	NC	0.000100	0.335	NA	**1.7**
Manganese	405	NC	405	0.0484	0.0238	0.0238	11.0	NA	0.41
Nickel	24.4	19.7	19.7	0.00221	0.00129	0.00129	0.345	NA	0.090
Selenium	1.60	1.01	1.01	0.00100	0.000579	0.000579	0.176	NA	0.18
Thallium	0.378	NC	0.378	0.000150	NC	0.000150	0.000518	NA	0.27
Uranium	2.37	NC	2.37	0.00120	0.000529	0.000529	0.00690	NA	0.18
Vanadium	45.2	33.0	33.0	0.00620	0.00140	0.00140	0.0548	NA	0.057
Zinc	151	107	107	0.0150	0.00525	0.00525	22.0	NA	0.38
							Cumulative ILCR/HQ:	**2E-04**	**5**
							IDEQ Point of Departure:	10^{-5}	1
							USEPA Risk Range:	10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration and ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in sediment or surface water samples collected from background sampling locations.

[b] The sediment EPC used to model culturally significant aquatic plants concentration is the 95% UCL on the mean concentration or the maximum detected concentration.

[c] The culturally significant aquatic plants EPCs for surface water constituents of potential concern were modeled from the sediment EPCs using sediment-to-plant uptake factors when sediment data were available.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk

mg/kg - milligrams per kilogarm
mg/L - milligrams per liter
NA - not applicable
NC - not calculated
USEPA - U. S. Environmental Protection Agency

Table E-41
Tier II Background Cancer Risk Calculation - Fish Consumption
Recreational Fisher, Native American and Hypothetical Future Resident

Analyte	Sediment Concentration[a] (mg/kg)	Surface Water Concentration[a] (mg/L)	Modeled Fish Concentration from Sediment (mg/kg wet weight)	Modeled Fish Concentration from Surface Water (mg/kg wet weight)	Fish Ingestion Dose (mg/kg-d)	Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$ [b] Oral	Chemical-Specific Risk
Arsenic	4.55	0.000735	0.0109	0.0838	1.8E-05	1.5E+00	**2.7E-05**
						ILCR	**3E-05**

Notes:

[a] Maximum detected concentration or 95% UCL on the mean concentration measured in sediment or surface water samples collected from background sampling locations.

[b] Doses and risks shown only for carcinogenic chemicals with available toxicity values.

95% UCL	95 percent upper confidence limit	mg/kg-d	milligrams per kilogram per day
ILCR	incremental lifetime cancer risk	mg/L	milligrams per liter
mg/kg	milligrams per kilogram		

Table E-42
Tier II Background Noncancer Hazard Calculation - Fish Consumption
Recreational Fisher, Native American and Hypothetical Future Resident

Analyte	Sediment Concentration[a] (mg/kg)	Surface Water Concentration (mg/L)	Modeled Fish Concentration from Sediment (mg/kg wet weight)	Modeled Fish Concentration from Surface Water (mg/kg wet weight)	Fish Ingestion Dose (mg/kg-d)	Reference Dose (mg/kg-d) [b] Oral	Chemical-Specific HQ
Antimony	5.00	NA	5.00	NA	2.5E-03	4.0E-04	**6.4**
Arsenic	4.55	0.000735	0.0109	0.0838	4.3E-05	3.0E-04	0.14
Thallium	0.378	0.000150	0.378	1.50	7.6E-04	1.0E-05	**76**
						HI	**83**

Notes:

[a] Maximum detected concentration or 95% UCL on the mean concentration measured in sediment or surface water samples collected from background sampling locations.

[b] Doses and noncancer hazards shown only for noncarcinogenic chemicals with available toxicity values.

95% UCL	95 percent upper confidence limit	mg/kg	milligrams per kilogram
HI	hazard index	mg/kg-d	milligrams per kilogram per day
HQ	hazard quotient	mg/L	milligrams per liter

Table E-43
Summary of Tier II Background Human Health Risk Estimates - Fish

Analyte	Sediment Concentration[a] (mg/kg)			Surface Water Concentration[a] (mg/L)			Modeled Fish Concentration (mg/kg)	Current/Future Recreational Fisher and Native American and Hypothetical Future Resident	
	Maximum	95% UCL	EPC[b]	Maximum	95% UCL	EPC[b]	EPC[c]	ILCR	HQ
Antimony	5.00	NC	5.00	NA	NA	NA	5.00	NA	**6.4**
Arsenic	4.55	NC	4.55	0.00110	0.000735	0.000735	0.0838	**2.7E-05**	0.14
Thallium	0.378	NC	0.378	0.000150	NC	0.000150	1.50	NA	**76**
Cumulative ILCR/HQ:								**3E-05**	**83**
IDEQ Point of Departure:								10^{-5}	1
USEPA Risk Range:								10^{-6} - 10^{-4}	1

Notes:

[a] Maximum detected concentration and ProUCL recommended 95%, 97.5% or 99% UCL on the mean concentration measured in sediment or surface water samples collected from background sampling locations.

[b] The sediment or surface water EPC used to model the fish concentration is the 95% UCL on the mean concentration or the maximum detected concentration.

[c] The fish EPCs for both surface water and sediment constituents of potential concern were modeled from the surface water EPCs using surface water-to-fish uptake factors when surface water data were available, otherwise they were modeled from the sediment EPCs using sediment-to-fish uptake factors.

Bold indicates exceedence of the USEPA's risk management range and/or IDEQ's point of departure.

% UCL - percent upper confidence limit
EPC - exposure point concentration
HQ - hazard quotient
IDEQ - Idaho Department of Environmental Quality
ILCR - incremental lifetime cancer risk

mg/kg - milligrams per kilogarm
mg/L - milligrams per liter
NA - not applicable
NC - not calculated
USEPA - U. S. Environmental Protection Agency

Table E-44

Tier II RME Background Radiological Risk Calculation for Current/Future Native Americans

Medium	Radium-226 EPC[a]		Pathway-Specific Radium-226 PRG [b]		Pathway-Specific Radium-226 Risk	Total Medium Radium-226 Risk
Culturally Significant Plants						
Upland Soil	4.80	pCi/g	0.0248	pCi/g	**1.9E-04**	**1.9E-04**
Elk [c]						
Upland Soil	NA	pCi/g	57.3	pCi/g	NA	NA
Upland Soil						
Incidental Ingestion	4.80	pCi/g	1.53	pCi/g	**3.1E-06**	**7.7E-05**
External Exposure	4.80	pCi/g	0.0650	pCi/g	**7.4E-05**	
Inhalation of Particulates	4.80	pCi/g	19,400	pCi/g	2.5E-10	
Aquatic Plants [d]						
Sediment	1.65	pCi/g	0.0474	pCi/g	**3.5E-05**	**3.5E-05**
					Total Site Media Risk:	**3E-04**
					IDEQ Point-of-departure:	**10^{-5}**
					USEPA Risk Range:	**10^{-6} - 10^{-4}**

Notes:

[a] The upland soil EPC was calculated from gamma count measurements at background sample locations according to the regression model described in the on-site and background areas radiological and soil investigation summary report (MWH, 2015). The sediment EPC was calculated based on the same total uranium to radium-226 conversion factor used to calculate water EPCs, with an additional uranium-238 to radium-226 ratio of 0.5 to 1, based on the approximate mean ratio for upland soils described in MWH (2015), applied.

[b] Preliminary Remediation Goals (PRGs) for radium-226+daughter products were calculated using the USEPA's online PRG calculator for radionuclides.

[c] Ingestion of elk was not evaluated in the Tier II HHRA because risks associated with this pathway in the Tier I HHRA did not exceed $1x10^{-6}$.

[d] Consistent with the evaluation for metals, the cumulative ILCR for the Native American includes the larger of the ILCR for radium-226 in upland or aquatic culturally significant plants. Because the PRG for aquatic plants is greater than the PRG for upland plants, aquatic plants are not included in the cumulative ILCR.

Bold indicates ILCR estimates above USEPA's risk management range or IDEQ's point of departure

EPC - Exposure point concentration
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
pCi/g - picocuries per gram
PRG - Preliminary Remediation Goal
RME - reasonable maximum exposure
USEPA - United States Environmental Protection Agency

Table E-45

Tier II RME Background Radiological Risk Calculation for Hypothetical Future Residents

Medium	Radium-226 EPC[a]		Pathway-Specific Radium-226 PRG [b]		Pathway-Specific Radium-226 Risk	Total Medium Radium-226 Risk
Fruits and Vegetables						
Upland Soil	4.80	pCi/g	0.0248	pCi/g	**1.9E-04**	**1.9E-04**
Upland Soil						
Incidental Ingestion	4.80	pCi/g	1.53	pCi/g	**3.1E-06**	**7.7E-05**
External Exposure	4.80	pCi/g	0.0650	pCi/g	**7.4E-05**	
Inhalation of Particulates	4.80	pCi/g	19,400	pCi/g	2.5E-10	
Medium	**Radon-222 EPC[a]**		**Pathway-Specific Radon-222 PRG [b]**		**Pathway-Specific Radon-222 Risk**	**Total Medium Radon-222 Risk**
Indoor Air	3,845	pCi/m^3	0.242	pCi/m^3	**1.6E-02**	**1.6E-02**
					Total Site Media Risk:	**2E-02**
					IDEQ Point-of-departure:	**10^{-5}**
					USEPA Risk Range:	**10^{-6} - 10^{-4}**

Notes:

[a] The upland soil EPC was calculated from gamma count measurements at background sample locations according to the regression model described in the on-site and background areas radiological and soil investigation summary report (MWH, 2015). The indoor air EPC was calculated from radon flux measurements from background sample locations (MWH, 2015).

[b] Preliminary Remediation Goals (PRGs) for radium-226+daughter products and radon-222+daughter products were calculated using the USEPA's online PRG calculator for radionuclides.

Bold indicates ILCR estimates above USEPA's risk management range or IDEQ's point of departure

EPC - Exposure point concentration
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
NA - not applicable
pCi/g - picocuries per gram
pCi/L - picocuries per liter
PRG - Preliminary Remediation Goal
RME - reasonable maximum exposure
USEPA - United States Environmental Protection Agency

Table E-46

Tier II RME Background Radiological Risk Calculation for a Current/Future Seasonal Rancher

Medium	Radium-226 EPC[a]		Pathway-Specific Radium-226 PRG [b]		Pathway-Specific Radium-226 Risk	Total Medium Radium-226 Risk
Cattle						
Upland Soil	4.80	pCi/g	0.631	pCi/g	**7.6E-06**	**7.6E-06**
Upland Soil						
Incidental Ingestion	4.80	pCi/g	5.15	pCi/g	9.3E-07	**1.6E-04**
External Exposure	4.80	pCi/g	0.0304	pCi/g	**1.6E-04**	
Inhalation of Particulates	4.80	pCi/g	8,190	pCi/g	5.9E-10	
					Total Site Media Risk:	**2E-04**
					IDEQ Point-of-departure:	**10^{-5}**
					USEPA Risk Range:	**10^{-6} - 10^{-4}**

Notes:

[a] The upland soil EPC was calculated from gamma count measurements at background sample locations according to the regression model described in the on-site and background areas radiological and soil investigation summary report (MWH, 2015).

[b] Preliminary Remediation Goals (PRGs) for radium-226+daughter products were calculated using the USEPA's online PRG calculator for radionuclides.

Bold indicates ILCR estimates above USEPA's risk management range or IDEQ's point of departure

EPC - Exposure point concentration
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
NA - not applicable
pCi/g - picocuries per gram
pCi/L - picocuries per liter
PRG - Preliminary Remediation Goal
RME - reasonable maximum exposure
USEPA - United States Environmental Protection Agency

Table E-47

Tier II RME Background Radiological Risk Calculation for a Current/Future Recreational Hunter

Medium	Radium-226 EPC[a]		Pathway-Specific Radium-226 PRG [b]		Pathway-Specific Radium-226 Risk	Total Medium Radium-226 Risk
Elk [c]						
Upland Soil	NA	pCi/g	30.2	pCi/g	NA	NA
Upland Soil						
Incidental Ingestion	4.80	pCi/g	44.2	pCi/g	1.1E-07	**3.7E-05**
External Exposure	4.80	pCi/g	0.130	pCi/g	**3.7E-05**	
Inhalation of Particulates	4.80	pCi/g	35,100	pCi/g	1.4E-10	
					Total Site Media Risk:	**4E-05**
					IDEQ Point-of-departure:	**10^{-5}**
					USEPA Risk Range:	**10^{-6} - 10^{-4}**

Notes:

[a] The upland soil EPC was calculated from gamma count measurements at background sample locations according to the regression model described in the on-site and background areas radiological and soil investigation summary report (MWH, 2015).

[b] Preliminary Remediation Goals (PRGs) for radium-226+daughter products were calculated using the USEPA's online PRG calculator for radionuclides.

[c] Ingestion of elk was not evaluated in the Tier II HHRA because risks associated with this pathway in the Tier I HHRA did not exceed $1x10^{-6}$.

Bold indicates ILCR estimates above USEPA's risk management range or IDEQ's point of departure

EPC - Exposure point concentration
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
pCi/g - picocuries per gram
pCi/L - picocuries per liter
PRG - Preliminary Remediation Goal
RME - reasonable maximum exposure
USEPA - United States Environmental Protection Agency

Table E-48

Tier II RME Background Radiological Risk Calculation for a Current/Future Recreational Camper / Hiker

Medium	Radium-226 EPC[a]		Pathway-Specific Radium-226 PRG [b]		Pathway-Specific Radium-226 Risk	Total Medium Radium-226 Risk
Upland Soil						
Incidental Ingestion	4.80	pCi/g	59.0	pCi/g	8.1E-08	**2.3E-05**
External Exposure	4.80	pCi/g	0.209	pCi/g	**2.3E-05**	
Inhalation of Particulates	4.80	pCi/g	62,500	pCi/g	7.7E-11	
					Total Site Media Risk:	**2E-05**
					IDEQ Point-of-departure:	**10^{-5}**
					USEPA Risk Range:	**10^{-6} - 10^{-4}**

Notes:

[a] The upland soil EPC was calculated from gamma count measurements at background sample locations according to the regression model described in the on-site and background areas radiological and soil investigation summary report (MWH, 2015).

[b] Preliminary Remediation Goals (PRGs) for radium-226+daughter products were calculated using the USEPA's online PRG calculator for radionuclides.

Bold indicates ILCR estimates above USEPA's risk management range or IDEQ's point of departure

EPC - Exposure point concentration
IDEQ - Idaho Department of Environmental Quality
ILCR - Incremental lifetime cancer risk
pCi/g - picocuries per gram
PRG - Preliminary Remediation Goal
RME - reasonable maximum exposure
USEPA - United States Environmental Protection Agency

ATTACHMENT F – TIER I HENRY SITE
ECOLOGICAL HAZARD CALCULATIONS

Table F-1
Tier I Henry Site Ecological Hazard Calculations for the Long-Tailed Vole

Constituent	EPC [a] C_{UP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	BAF_{S-P} [b]	EPC C_{PLANT} [c] (mg/kg)	Measured Plant Concentration [d] (mg/kg)	Ingestion Dose [e] (mg/kg-day)	TRV NOAEL (mg/kg-day)	Ecological Hazard
Aluminum	NA	0.905	NA	NA	NA	1.2E-01	1.9E+00	0.065
Antimony	9.15	NA	Regression	0.315	0.518	2.3E-01	5.9E-02	**3.9**
Arsenic	45.5	NA	0.0375	1.71	10.2	3.5E+00	1.0E+00	**3.4**
Barium	NA	0.0810	NA	NA	NA	1.1E-02	5.2E+01	0.00022
Boron	39.0	0.121	4	156	47.3	1.5E+01	2.8E+01	0.53
Cadmium	59.5	0.0352	Regression	5.79	5.56	2.2E+00	7.7E-01	**2.8**
Chromium	519	NA	0.041	21.3	18.2	9.5E+00	2.4E+00	**3.9**
Cobalt	NA	0.0141	NA	NA	NA	2E-03	7.3E+00	0.00026
Copper	172	NA	Regression	14.8	15.4	6.0E+00	5.6E+00	1.1
Manganese	NA	2.44	0.079	NA	NA	3.4E-01	5.2E+01	0.007
Mercury	0.503	NA	Regression	0.265	0.0687	2.5E-02	1.0E+00	0.025
Molybdenum	35.7	NA	0.25	8.93	125	3.9E+01	2.6E-01	**149**
Nickel	425	1.26	Regression	10.0	17.4	8.7E+00	1.7E+00	**5.1**
Selenium	318	0.970	Regression	294	146	4.8E+01	1.4E-01	**333**
Silver	7.30	NA	0.014	0.102	0.164	1.0E-01	6.0E+00	0.017
Thallium	2.31	NA	0.004	0.00924	0.713	2.4E-01	3.7E-03	**64**
Uranium	74.4	0.0206	0.0085	0.632	1.27	9.5E-01	3.1E+00	0.31
Vanadium	584	0.0885	0.00485	2.83	13.1	8.4E+00	4.2E+00	**2.0**
Zinc	1,610	4.73	Regression	289	231	8.4E+01	7.5E+01	**1.1**

Notes:
BAF_{S-P} - bioaccumulation factor from soil to plants
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
mg/L - milligrams per liter
NA - not applicable
na - not available
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	0.037	kg
Food Ingestion Rate (FIR):	0.0115	kg (dry wt)/day
FIR_Plants (100%):	0.0115	kg (dry wt)/day
FIR_Soil (2.4%):	0.00028	kg (dry wt)/day
Water Ingestion Rate:	0.0051	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	0.066	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier I Ecological Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at the Henry Site.
[b] The soil-to-plant bioconcentration factor was derived from sources listed in Table A4-13 and A4-15.
[c] The plant concentration (C_{PLANT}) was calculated from the upland soil concentration and the soil-to-plant bioconcentration factor (BCF_{S-P}).
[d] The measured plant concentration is equal to the maximum concentration detected in plant tissue collected from Henry Site.
[e] The ingestion dose for the long-tailed vole accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from upland soil.

Table F-2
Tier I Henry Site Ecological Hazard Calculations for Elk

Constituent	EPC [a] C_{UP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	BAF_{S-P} [b]	EPC C_{PLANT} [c] (mg/kg)	Measured Plant Concentration [d] (mg/kg)	Ingestion Dose [e] (mg/kg-day)	TRV NOAEL (mg/kg-day)	Ecological Hazard
Aluminum	NA	0.905	NA	NA	NA	3.2E-03	1.9E+00	0.0016
Antimony	9.15	NA	Regression	0.315	0.518	3.5E-04	5.9E-02	0.0059
Arsenic	45.5	NA	0.0375	1.71	10.2	5.5E-03	1.0E+00	0.0053
Barium	NA	0.0810	NA	NA	NA	2.8E-04	5.2E+01	0.0000054
Boron	39.0	0.121	4.0	156	47.3	2.4E-02	2.8E+01	0.00087
Cadmium	59.5	0.0352	Regression	5.79	5.56	3.5E-03	7.7E-01	0.0045
Chromium	519	NA	0.041	21.3	18.2	1.4E-02	2.4E+00	0.0059
Cobalt	NA	0.0141	NA	NA	NA	5E-05	7.3E+00	0.0000067
Copper	172	NA	Regression	14.8	15.4	9.4E-03	5.6E+00	0.0017
Manganese	NA	2.44	0.079	NA	NA	8.5E-03	5.2E+01	0.0002
Mercury	0.503	NA	Regression	0.265	0.0687	3.9E-05	1.0E+00	0.000039
Molybdenum	35.7	NA	0.25	8.93	125	6.2E-02	2.6E-01	0.24
Nickel	425	1.26	Regression	10.0	17.4	1.7E-02	1.7E+00	0.010
Selenium	318	0.970	Regression	294	146	7.9E-02	1.4E-01	0.55
Silver	7.30	NA	0.014	0.102	0.164	1.5E-04	6.0E+00	0.000026
Thallium	2.31	NA	0.004	0.00924	0.713	3.8E-04	3.7E-03	0.10
Uranium	74.4	0.0206	0.0085	0.632	1.27	1.4E-03	3.1E+00	0.00047
Vanadium	584	0.0885	0.00485	2.83	13.1	1.3E-02	4.2E+00	0.0030
Zinc	1,610	4.73	Regression	289	231	1.5E-01	7.5E+01	0.0020

Notes:
BAF_{S-P} - bioaccumulation factor from soil to plants
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
mg/L - milligrams per liter
NA - not applicable
na - not available
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	286	kg
Food Ingestion Rate (FIR):	2.29	kg (dry wt)/day
FIR_Plants (100%):	2.29	kg (dry wt)/day
FIR_Soil (2%):	0.0459	kg (dry wt)/day
Water Ingestion Rate:	16.1	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	0.0619	unitless
Home range:	16,640	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier I Ecological Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at the Henry Site.
[b] The soil-to-plant bioconcentration factor was derived from sources listed in Table A4-13 and A4-15.
[c] The plant concentration (C_{PLANT}) was calculated from the upland soil concentration and the soil-to-plant bioconcentration factor (BCF_{S-P}).
[d] The measured plant concentration is equal to the maximum concentration detected in plant tissue collected from Henry Site.
[e] The ingestion dose for the elk accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from upland soil.

Table F-3
Tier I Henry Site Ecological Hazard Calculations for the American Goldfinch

Constituent	EPC [a] C_{UP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	BAF_{S-P} [b]	EPC C_{PLANT} [c] (mg/kg)	Measured Plant Concentration [d] (mg/kg)	Ingestion Dose [e] (mg/kg-day)	TRV NOAEL (mg/kg-day)	Ecological Hazard
Aluminum	NA	0.905	NA	NA	NA	2.1E-01	1.1E+02	0.0019
Antimony	9.15	NA	Regression	0.315	0.518	3.9E-01	na	na
Arsenic	45.5	NA	0.0375	1.71	10.2	3.9E+00	2.2E+00	**1.8**
Barium	NA	0.0810	NA	NA	NA	1.9E-02	2.1E+01	0.00091
Boron	39.0	0.121	4.0	156	47.3	1.4E+01	2.9E+01	0.47
Cadmium	59.5	0.0352	Regression	5.79	5.56	3.1E+00	1.5E+00	**2.1**
Chromium	519	NA	0.041	21.3	18.2	1.9E+01	2.7E+00	**7.2**
Cobalt	NA	0.0141	NA	NA	NA	3.3E-03	7.6E+00	0.00043
Copper	172	NA	Regression	14.8	15.4	8.8E+00	4.1E+00	**2.2**
Manganese	NA	2.44	0.079	NA	NA	5.7E-01	1.8E+02	0.003
Mercury	0.503	NA	Regression	0.265	0.0687	3.2E-02	4.5E-01	0.071
Molybdenum	35.7	NA	0.25	8.93	125	3.4E+01	3.5E+00	**9.7**
Nickel	425	1.26	Regression	10.0	17.4	1.7E+01	6.7E+00	**2.5**
Selenium	318	0.970	Regression	294	146	4.8E+01	2.9E-01	**164**
Silver	7.30	NA	0.014	0.102	0.164	2.4E-01	2.0E+00	0.12
Thallium	2.31	NA	0.004	0.00924	0.713	2.5E-01	3.5E-01	0.73
Uranium	74.4	0.0206	0.0085	0.632	1.27	2.4E+00	1.6E+01	0.15
Vanadium	584	0.0885	0.00485	2.83	13.1	2.0E+01	3.4E-01	**57**
Zinc	1,610	4.73	Regression	289	231	1.1E+02	6.6E+01	**1.6**

Notes:
BAF_{S-P} - bioaccumulation factor from soil to plants
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
mg/L - milligrams per liter
NA - not applicable
na - not available
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	0.0155	kg
Food Ingestion Rate (FIR):	0.0041	kg (dry wt)/day
FIR_Plants (100%):	0.0041	kg (dry wt)/day
FIR_Soil (10.4%):	0.000426	kg (dry wt)/day
Water Ingestion Rate:	0.00362	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	0.119	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier I Ecological Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at the Henry Site.
[b] The soil-to-plant bioconcentration factor was derived from sources listed in Table A4-13 and A4-15.
[c] The plant concentration (C_{PLANT}) was calculated from the upland soil concentration and the soil-to-plant bioconcentration factor (BCF_{S-P}).
[d] The measured plant concentration is equal to the maximum concentration detected in plant tissue collected from Henry Site.
[e] The ingestion dose for the American goldfinch accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from upland soil.

Table F-4
Tier I Henry Site Ecological Hazard Calculations for the Deer Mouse

	EPC [a]			EPC	Measured Plant		EPC	Ingestion	TRV	Ecological
Constituent	**C_{UP_SOIL} (mg/kg)**	**C_{WATER} (mg/L)**	**BAF_{S-P} [b]**	**C_{PLANT} [c] (mg/kg)**	**Concentration [d] (mg/kg)**	**BAF_{S-I} [b]**	**C_{INVERT} [c] (mg/kg)**	**Dose [e] (mg/kg-day)**	**NOAEL (mg/kg-day)**	**Hazard**
Aluminum	NA	0.905	NA	NA	NA	NA	NA	1.3E-01	1.9E+00	0.069
Antimony	9.15	NA	Regression	0.315	0.518	1	9.15	7.9E-01	5.9E-02	**13**
Arsenic	45.5	NA	0.0375	1.71	10.2	Regression	3.58	1.7E+00	1.0E+00	**1.6**
Barium	NA	0.0810	NA	NA	NA	NA	NA	1.2E-02	5.2E+01	0.00023
Boron	39.0	0.121	4.0	156	47.3	1	39.0	8.8E+00	2.8E+01	0.31
Cadmium	59.5	0.0352	Regression	5.79	5.56	Regression	213	1.7E+01	7.7E-01	**22**
Chromium	519	NA	0.041	21.3	18.2	0.306	159	1.6E+01	2.4E+00	**6.7**
Cobalt	NA	0.0141	NA	NA	NA	NA	NA	2.1E-03	7.3E+00	0.00028
Copper	172	NA	Regression	14.8	15.4	0.515	88.6	9.2E+00	5.6E+00	**1.6**
Manganese	NA	2.44	0.079	NA	NA	Regression	NA	3.6E-01	5.2E+01	0.007
Mercury	0.503	NA	Regression	0.265	0.0687	Regression	0.465	4.5E-02	1.0E+00	0.045
Molybdenum	35.7	NA	0.25	8.93	125	1	35.7	1.8E+01	2.6E-01	**69**
Nickel	425	1.26	Regression	10.0	17.4	1	425	3.6E+01	1.7E+00	**21**
Selenium	318	0.970	Regression	294	146	Regression	63.3	2.4E+01	1.4E-01	**166**
Silver	7.30	NA	0.014	0.102	0.164	2.045	14.9	1.2E+00	6.0E+00	0.19
Thallium	2.31	NA	0.0040	0.00924	0.713	1	2.31	2.7E-01	3.7E-03	**73**
Uranium	74.4	0.0206	0.0085	0.632	1.27	1	74.4	6.0E+00	3.1E+00	**2.0**
Vanadium	584	0.0885	0.00485	2.83	13.1	0.042	24.5	5.7E+00	4.2E+00	**1.4**
Zinc	1,610	4.73	Regression	289	231	Regression	964	1.1E+02	7.5E+01	**1.4**

Notes:

BAF_{S-I} - bioaccumulation factor from soil to invertebrates
BAF_{S-P} - bioaccumulation factor from soil to plants
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
na - not available
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	0.0195	kg
Food Ingestion Rate (FIR):	0.0038	kg (dry wt)/day
FIR_Plants (61.5%):	0.0023	kg (dry wt)/day
FIR_Inverts (38.5%):	0.0015	kg (dry wt)/day
FIR_Soil (2%):	0.0001	kg (dry wt)/day
Water Ingestion Rate:	0.0029	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	0.27	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier I Ecological Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at the Henry Site.

[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 and A4-15.

[c] The plant (C_{PLANT}) and terrestrial invertebrate (C_{INVERT}) concentrations were calculated from upland soil concentration and the soil-to-biota bioconcentration factors (BCF_{S-P} and

[d] The measured plant concentration is equal to the maximum concentration detected in plant tissue collected from Henry Site.

[e] The ingestion dose for the deer mouse accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from upland soil.

Table F-5
Tier I Henry Site Ecological Hazard Calculations for the Raccoon

Constituent	EPC [a] C_{RIP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	EPC [a] $C_{SEDIMENT}$ (mg/kg)	BAF_{S-P} [b]	EPC C_{PLANT} [c] (mg/kg)	Measured Plant Concentration [d] (mg/kg)	BAF_{S-I} [b]	EPC C_{INVERT} [c] (mg/kg)	BAF_{S-V} [b]	EPC $C_{VERTEBRATES}$ [c] (mg/kg)	BAF_{Sed-I} [b]	BAF_{W-I} [b]	EPC $C_{AQ\ INVERT}$ [c,e] (mg/kg)	BCF_{Sed-F} [b]	BCF_{W-F} [b]	EPC C_{FISH} [c, e] (mg/kg)	Ingestion Dose [f] (mg/kg-day)	TRV NOAEL (mg/kg-day)	Ecological Hazard
Aluminum	NA	0.905	NA	NA	NA	NA	NA	NA	NA	NA	NA	24,355	22,042	1	13.5	12.2	1.9E+01	1.9E+00	**9.6**
Antimony	7.00	0.00230	8.50	Regression	0.245	na	1	7.00	0.05	0.350	1.0	41.9	8.50	1	200	0.460	3.3E-02	5.9E-02	0.57
Arsenic	NA	0.0224	10.6	NA	NA	NA	NA	NA	NA	NA	Regression	437.3	3.03	0.012	570	12.8	4.1E-03	1.0E+00	0.0039
Barium	NA	0.0810	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,198	97.0	1	3,165	256	1.2E-01	5.2E+01	0.0022
Boron	5.90	0.121	17.4	4.0	23.6	na	1	5.90	1	5.9	1	1	17.4	1	1	0.121	2.3E-01	2.8E+01	0.0081
Cadmium	67.3	0.0352	104	Regression	6.19	2.87	Regression	235	Regression	2.08	Regression	20,731	27.2	0.785	4,535	160	6.8E-01	7.7E-01	0.88
Chromium	467	0.00760	1,030	0.041	19.1	na	0.306	143	Regression	21.1	Regression	17,970	20.4	0.043	95.00	0.722	1.0E+00	2.4E+00	0.43
Cobalt	NA	0.0141	10.6	NA	NA	NA	NA	NA	NA	NA	0.122	1	1.29	1	1	0.0141	1.6E-03	7.3E+00	0.00022
Copper	56.0	0.00379	68.8	Regression	9.53	7.70	0.515	28.8	Regression	13.8	Regression	22,271	39.8	1	3,550	13.5	2.4E-01	5.6E+00	0.043
Manganese	NA	2.44	2,580	NA	NA	NA	NA	NA	NA	NA	Regression	1	94.5	1	1	2.4	1.7E-01	5.2E+01	0.003
Mercury	0.0240	ND	0.236	Regression	0.0516	na	Regression	0.325	0.1920	0.00461	Regression	1	0.133	0.38	1	0.0897	1.3E-03	1.0E+00	0.0013
Molybdenum	14.8	0.0400	10.8	0.25	3.70	19.3	1	14.8	1	14.8	1	1	10.8	1	1	0.0400	2.2E-01	2.6E-01	0.86
Nickel	251	1.26	1,110	Regression	6.75	na	1	251	Regression	10.3	Regression	168	1.53	1	390	491	1.0E+00	1.7E+00	0.60
Selenium	45.0	0.970	148	Regression	34.0	65.0	Regression	15.1	Regression	2.76	Regression	7559.4	36.2	1	645	626	7.3E-01	1.4E-01	**5.1**
Silver	NA	ND	2.16	NA	NA	NA	NA	NA	NA	NA	2.05	1,785	4.42	1	439	2.16	4.0E-03	6.0E+00	0.00066
Thallium	0.223	0.000348	2.17	0.0040	0.000892	na	1	0.223	0.1124	0.0251	1	89,850	2.17	1	50,000	17.4	4.7E-03	3.7E-03	**1.3**
Uranium	1.66	0.0206	90.0	0.0085	0.0141	na	1	1.66	1	1.66	1	1	90.0	1	1	0.0206	8.4E-02	3.1E+00	0.027
Vanadium	773	0.0885	940	0.00485	3.75	na	0.042	32.5	0.012	9.51	0.04	1	39.5	1	1	0.0885	1.0E+00	4.2E+00	0.25
Zinc	1,600	4.73	7,940	Regression	288	335	Regression	962	Regression	132	Regression	27,422	408	1.833	10,295	48,695	1.3E+01	7.5E+01	0.17

Notes:
BAF_{S-I} - bioaccumulation factor from soil to invertebrates
BAF_{S-P} - bioaccumulation factor from soil to plants
BAF_{S-V} - bioaccumulation factor from soil to terrestrial vertebrates
BAF_{Sed-F} - bioaccumulation factor from sediment to fish
BAF_{Sed-I} - bioaccumulation factor from sediment to aquatic invertebrates
BAF_{W-F} - bioaccumulation factor from water to fish
BAF_{W-I} - bioaccumulation factor from water to aquatic invertebrates
C_{FISH} - Fish Concentration
C_{RIP_SOIL} - Riparian Soil Concentration
$C_{SEDIMENT}$ - Sediment Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
na - not available
ND - not detected
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	5.8	kg
Food Ingestion Rate (FIR):	0.154	kg (dry wt)/day
FIR_Terrestrial Plants (64%):	0.0985	kg (dry wt)/day
FIR_Terrestrial Inverts (19%):	0.0292	kg (dry wt)/day
FIR_Terrestrial Vertebrates (9%):	0.0138	kg (dry wt)/day
FIR_Upland Soil (0%):	0	kg (dry wt)/day
FIR_Aquatic Plants (0%):	0	kg (dry wt)/day
FIR_Aquatic Inverts (7%):	0.0108	kg (dry wt)/day
FIR_Fish (1%):	0.0015	kg (dry wt)/day
FIR_Riparian Soil (9.4%):	0.0145	kg (dry wt)/day
Water Ingestion Rate:	0.4816	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	0.453	unitless
Home range:	2,272	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier I Ecological Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at the Henry Site. Exposure point concentrations are shown for both surface water and sediment for metals that were COPECs in either medium for biota uptake modeling.

[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 through A4-15.

[c] The terrestrial plant (C_{PLANT}), terrestrial invertebrate (C_{INVERT}), terrestrial vertebrate ($C_{VERTIBRATE}$), aquatic invertebrate ($C_{AQ\ INVERT}$), and fish (C_{FISH}) concentrations were calculated from the soil, sediment, or surface water concentration and the soil, sediment-, or surface water-to-biota bioconcentration factors.

[d] The measured plant concentration is equal to the maximum concentration detected in plant tissue collected from Henry Site.

[e] The aquatic invertebrate EPC is calculated using the sediment to invertebrate BAF for analytes detected in sediment; otherwise the aquatic invertebrate EPC is based on the water to invertebrate BAF. The fish EPC is calculated using the water to fish BAF for analytes detected in surface water; otherwise the fish EPC is based on the sediment to fish BAF.

[f] The ingestion dose for the raccoon accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from riparian soil.

Table F-6
Tier I Henry Site Ecological Hazard Calculations for the American Robin

Constituent	EPC [a] C_{UP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	BAF_{S-P} [b]	EPC C_{PLANT} [c] (mg/kg)	Measured Plant Concentration [d] (mg/kg)	BAF_{S-I} [b]	EPC C_{INVERT} [c] (mg/kg)	Ingestion Dose [e] (mg/kg-day)	TRV NOAEL (mg/kg-day)	Ecological Hazard
Aluminum	NA	0.905	NA	NA	NA	NA	NA	1.2E-01	1.1E+02	0.0011
Antimony	9.15	NA	Regression	0.315	0.518	1	9.15	8.1E-01	na	na
Arsenic	45.5	NA	0.0375	1.71	10.2	Regression	3.58	1.5E+00	2.2E+00	0.65
Barium	NA	0.0810	NA	NA	NA	NA	NA	1.1E-02	2.1E+01	0.00052
Boron	39.0	0.121	4.0	156	47.3	1	39.0	6.1E+00	2.9E+01	0.21
Cadmium	59.5	0.0352	Regression	5.79	5.56	Regression	213	1.6E+01	1.5E+00	**11**
Chromium	519	NA	0.041	21.3	18.2	0.306	159	1.9E+01	2.7E+00	**7.3**
Cobalt	NA	0.0141	NA	NA	NA	NA	NA	1.9E-03	7.6E+00	0.00025
Copper	172	NA	Regression	14.8	15.4	0.515	88.6	9.6E+00	4.1E+00	**2.4**
Manganese	NA	2.44	0.079	NA	NA	Regression	NA	3.3E-01	1.8E+02	0.002
Mercury	0.503	NA	Regression	0.265	0.0687	Regression	0.465	4.4E-02	4.5E-01	0.098
Molybdenum	35.7	NA	0.25	8.93	125	1	35.7	1.0E+01	3.5E+00	**2.9**
Nickel	425	1.26	Regression	10.0	17.4	1	425	3.7E+01	6.7E+00	**5.6**
Selenium	318	0.970	Regression	294	146	Regression	63.3	1.7E+01	2.9E-01	**60**
Silver	7.30	NA	0.014	0.102	0.164	2.045	14.9	1.2E+00	2.0E+00	0.58
Thallium	2.31	NA	0.0040	0.00924	0.713	1	2.31	2.4E-01	3.5E-01	0.69
Uranium	74.4	0.0206	0.0085	0.632	1.27	1	74.4	6.4E+00	1.6E+01	0.40
Vanadium	584	0.0885	0.00485	2.83	13.1	0.042	24.5	1.0E+01	3.4E-01	**30**
Zinc	1,610	4.73	Regression	289	231	Regression	964	1.0E+02	6.6E+01	**1.6**

Notes:
BAF_{S-I} - bioaccumulation factor from soil to invertebrates
BAF_{S-P} - bioaccumulation factor from soil to plants
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
na - not available
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Parameter	Value	Units
Body Weight:	0.08195	kg
Food Ingestion Rate (FIR):	0.0106	kg (dry wt)/day
FIR_Plants (44.7%):	0.0047	kg (dry wt)/day
FIR_Inverts (55.3%):	0.0059	kg (dry wt)/day
FIR_Soil (10.4%):	0.0011	kg (dry wt)/day
Water Ingestion Rate:	0.0110	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	0.72	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier I Ecological Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at the Henry Site.
[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 and A4-15.
[c] The plant (C_{PLANT}) and terrestrial invertebrate (C_{INVERT}) concentrations were calculated from upland soil concentration and the soil-to-biota bioconcentration factors (BCF_{S-P} and BCF_{S-I}).
[d] The measured plant concentration is equal to the maximum concentration detected in plant tissue collected from Henry Site.
[e] The ingestion dose for the American robin accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from upland soil.

Table F-7
Tier I Henry Site Ecological Hazard Calculations for the Mallard

	EPC[a]				EPC			EPC	Ingestion	TRV	Ecological
Constituent	C_{WATER} (mg/L)	$C_{SEDIMENT}$ (mg/kg)	$BAF_{Sed\text{-}P}$ [b]	$BAF_{W\text{-}P}$ [b]	$C_{AQ\ PLANT}$ [c] (mg/kg)	$BAF_{Sed\text{-}I}$ [b]	$BAF_{W\text{-}I}$ [b]	$C_{AQ\ INVERT}$ [c] (mg/kg)	Dose [d] (mg/kg-day)	NOAEL (mg/kg-day)	Hazard
Aluminum	0.905	NA	NA	2,432	2,201	NA	24,355	22,042	7.8E+02	1.1E+02	**7.1**
Antimony	0.00230	8.50	Regression	4,307	0.294	1	42	8.50	3.1E-01	na	na
Arsenic	0.0224	10.6	0.0375	856	0.398	Regression	437	3.03	1.2E-01	2.2E+00	0.056
Barium	0.0810	NA	NA	759	61.5	NA	1,198	97.0	4.1E+00	2.1E+01	0.19
Boron	0.121	17.4	4	1	69.6	1	1	17.4	1.4E+00	2.9E+01	0.050
Cadmium	0.0352	104	Regression	2,283	7.85	Regression	20,731	27.2	1.2E+00	1.5E+00	0.81
Chromium	0.00760	1,030	0.041	12,866	42.2	Regression	17,970	20.4	2.8E+00	2.7E+00	1.0
Cobalt	0.0141	10.6	0.0075	1	0.0795	0.1	1	1.29	4.6E-02	7.6E+00	0.0061
Copper	0.00379	68.8	Regression	1,580	10.3	Regression	22,271	39.8	1.6E+00	4.1E+00	0.39
Manganese	2.44	2,580	0.079	1	204	Regression	1	420	2.1E+01	1.8E+02	0.12
Mercury	ND	0.236	Regression	1	0.176	Regression	1	0.133	7.0E-03	4.5E-01	0.016
Molybdenum	0.0400	10.8	0.25	1	2.70	1	1	10.8	4.2E-01	3.5E+00	0.12
Nickel	1.26	1,110	Regression	178	20.5	Regression	168	1.53	2.0E+00	6.7E+00	0.30
Selenium	0.970	148	Regression	5,387	126	Regression	7,559	81.1	4.5E+00	2.9E-01	**16**
Silver	ND	2.16	0.014	31,232	0.0302	2.045	1,785	4.42	1.6E-01	2.0E+00	0.077
Thallium	0.000348	2.17	0.004	43,800	0.00868	1	89,850	2.17	7.8E-02	3.5E-01	0.23
Uranium	0.0206	90.0	0.0085	1	0.765	1	1	90.0	3.2E+00	1.6E+01	0.20
Vanadium	0.0885	940	0.00485	1	4.56	0.042	1	39.5	2.8E+00	3.4E-01	**8.3**
Zinc	4.73	7,940	Regression	6,351	699	Regression	27,422	408	3.4E+01	6.6E+01	0.52

Notes:

$BAF_{Sed\text{-}I}$ - bioaccumulation factor from sediment to aquatic invertebrates
$BAF_{Sed\text{-}P}$ - bioaccumulation factor from sediment to aquatic plants
$BCF_{W\text{-}I}$ - bioaccumulation factor from water to aquatic invertebrates
$BCF_{W\text{-}P}$ - bioaccumulation factor from water to aquatic plants
$C_{SEDIMENT}$ - Sediment Concentration
C_{WATER} - Surface Water Concentration

EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
ND - not detected
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	1.178	kg
Food Ingestion Rate (FIR):	0.056	kg (dry wt)/day
FIR_Aquatic Plants (25%):	0.01	kg (dry wt)/day
FIR_Aquatic Inverts (75%):	0.0422	kg (dry wt)/day
FIR_Sediment (3.3%):	0.0019	kg (dry wt)/day
Water Ingestion Rate:	0.066	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	0.959	unitless
Home range:	1,074	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier I Ecological Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at the Henry Site. The measured plant concentration is equal to the maximum concentration detected in plant tissue collected from Henry Site. Exposure point concentrations are shown for both surface water and sediment for metals that were COPECs in either medium for biota uptake modeling.

[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-14 and A4-15.

[c] The aquatic plant ($C_{AQ\ PLANT}$) and aquatic invertebrate ($C_{AQ\ INVERT}$) concentrations were calculated from the sediment concentration and the sediment-to-biota bioaccumulation factors.

[d] The ingestion dose for the mallard accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16.

Table F-8
Tier I Henry Site Ecological Hazard Calculations for the Mink

	EPC [a]				EPC			EPC			EPC	Ingestion	TRV	Ecological
	C_{RIP_SOIL}	C_{WATER}	$C_{SEDIMENT}$	BAF_{S-V} [b]	$C_{VERTEBRATES}$ [c]	BAF_{Sed-I} [b]	BAF_{W-I} [b]	$C_{AQ\ INVERT}$ [c,d]	BCF_{Sed-F} [b]	BCF_{W-F} [b]	C_{FISH} [c,d]	Dose [e]	NOAEL	Hazard
Constituent	**(mg/kg)**	**(mg/L)**	**(mg/kg)**		**(mg/kg)**			**(mg/kg)**			**(mg/kg)**	**(mg/kg-day)**	**(mg/kg-day)**	
Aluminum	NA	0.905	NA	NA	NA	NA	24,355	22,042	1	13.5	12.2	6.4E+02	1.9E+00	**329**
Antimony	7.00	0.00230	8.50	0.05	0.350	1	42	8.50	1	200	0.460	7.3E-01	5.9E-02	**12**
Arsenic	NA	0.0224	10.6	NA	NA	Regression	437	3.03	0.0120	570	12.8	2.0E+00	1.0E+00	**1.9**
Barium	NA	0.0810	NA	NA	NA	NA	1,198	97.0	1	3,165	256	4.1E+01	5.2E+01	0.79
Boron	5.90	0.121	17.4	1	5.90	1	1	17.4	1	1	0.121	2.6E+00	2.8E+01	0.092
Cadmium	67.3	0.0352	104	Regression	2.08	Regression	20,731	27.2	0.785	4,535	160	2.8E+01	7.7E-01	**37**
Chromium	467	0.00760	1,030	Regression	21.1	Regression	17,970	20.4	0.0430	95	0.722	2.8E+01	2.4E+00	**12**
Cobalt	NA	0.0141	10.6	NA	NA	0.12	1	1.29	1	1	0.0141	4.1E-02	7.3E+00	0.0055
Copper	56.0	0.00379	68.8	Regression	13.781	Regression	22,271	39.8	1	3,550	13.5	9.8E+00	5.6E+00	**1.8**
Manganese	NA	2.44	2,580	NA	NA	Regression	1	94.5	1	1	2.4	3.3E+00	5.2E+01	0.06
Mercury	0.0240	ND	0.236	0.1920	0.00461	Regression	1	0.133	0.380	1	0.0897	2.0E-02	1.0E+00	0.019
Molybdenum	14.8	0.0400	10.8	1	14.8	1	1	10.8	1	1	0.0400	5.5E+00	2.6E-01	**21**
Nickel	251	1.26	1,110	Regression	10.3	Regression	168	1.53	1	390	491	8.8E+01	1.7E+00	**52**
Selenium	45.0	0.970	148	Regression	2.76	Regression	7,559	36.2	1	645	626	9.7E+01	1.4E-01	**679**
Silver	NA	ND	2.16	NA	NA	2.045	1,785	4.42	1	438.6	2.16	4.5E-01	6.0E+00	0.075
Thallium	0.223	0.000348	2.17	0.1124	0.0251	1	89,850	2.17	1	50,000	17.4	2.7E+00	3.7E-03	**722**
Uranium	1.66	0.0206	90.0	1	1.66	1	1	90.0	1	1	0.0206	3.2E+00	3.1E+00	1.0
Vanadium	773	0.0885	940	0.012	9.51	0.042	1	39.5	1	1	0.0885	3.9E+01	4.2E+00	**9.4**
Zinc	1,600	4.73	7,940	Regression	132	Regression	27,422	408	1.83	10,295	48,695	7.4E+03	7.5E+01	**98**

Notes:

BAF_{S-V} - bioaccumulation factor from soil to terrestrial vertebrates
BAF_{Sed-I} - bioaccumulation factor from sediment to aquatic invertebrates
BAF_{Sed-F} - bioaccumulation factor from sediment to fish
BAF_{W-I} - bioaccumulation factor from water to aquatic invertebrates
BAF_{W-F} - bioaccumulation factor from water to fish
C_{FISH} - Fish Concentration
C_{RIP_SOIL} - Riparian Soil Concentration
$C_{SEDIMENT}$ - Sediment Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient

mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
ND - not detected
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	1.075	kg
Food Ingestion Rate (FIR):	0.516	kg (dry wt)/day
FIR_Terrestrial Vertebrates (63%):	0.3252	kg (dry wt)/day
FIR_Upland Soil (0%):	0	kg (dry wt)/day
FIR_Aquatic Inverts (6%):	0.0309	kg (dry wt)/day
FIR_Fish (31%):	0.16	kg (dry wt)/day
FIR_Riparian Soil (9.4%):	0.0485	kg (dry wt)/day
Water Ingestion Rate:	0.106	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	50	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier I Ecological Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at the Henry Site. Exposure point concentrations are shown for both surface water and sediment for metals that were COPECs in either medium for biota uptake modeling.

[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 through A4-15.

[c] The aquatic invertebrate ($C_{AQ\ INVERT}$), fish (C_{FISH}), and terrestrial vertebrate ($C_{VERTIBRATE}$) concentrations were calculated from the soil, sediment, or surface water concentration and the soil, sediment-, or surface water-to-biota bioconcentration factors.

[d] The aquatic invertebrate EPC is calculated using the sediment to invertebrate BAF for analytes detected in sediment; otherwise the aquatic invertebrate EPC is based on the water to invertebrate BAF. The fish EPC is calculated using the water to fish BAF for analytes detected in surface water; otherwise the fish EPC is based on the sediment to fish BAF.

[e] The ingestion dose for the mink accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16.

Table F-9
Tier I Henry Site Ecological Hazard Calculations for the Coyote

Constituent	EPC [a] C_{UP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	BAF_{S-P} [b]	EPC C_{PLANT} [c] (mg/kg)	Measured Plant Concentration [d] (mg/kg)	BAF_{S-I} [b]	EPC C_{INVERT} [c] (mg/kg)	BAF_{S-V} [b]	EPC $C_{VERTEBRATE}$ [c] (mg/kg)	Ingestion Dose [e] (mg/kg-day)	TRV NOAEL (mg/kg-day)	Ecological Hazard
Aluminum	NA	0.905	NA	NA	NA	NA	NA	NA	NA	9.8E-03	1.9E+00	0.0051
Antimony	9.15	NA	Regression	0.315	0.518	1	9.15	0.05	0.458	4.0E-02	5.9E-02	0.68
Arsenic	45.5	NA	0.0375	1.71	10.2	Regression	3.58	Regression	0.179	7.7E-02	1.0E+00	0.074
Barium	NA	0.0810	NA	NA	NA	NA	NA	NA	NA	8.8E-04	5.2E+01	0.000017
Boron	39.0	0.121	4.0	156	47.3	1	39.0	1	39.0	1.8E+00	2.8E+01	0.065
Cadmium	59.5	0.0352	Regression	5.79	5.56	Regression	213	Regression	1.96	3.6E-01	7.7E-01	0.46
Chromium	519	NA	0.041	21.3	18.2	0.306	159	Regression	22.8	1.8E+00	2.4E+00	0.75
Cobalt	NA	0.0141	NA	NA	NA	NA	NA	NA	NA	1.5E-04	7.3E+00	0.000021
Copper	172	NA	Regression	14.8	15.4	0.515	88.6	Regression	16.2	1.0E+00	5.6E+00	0.18
Manganese	NA	2.44	0.079	NA	NA	NA	NA	NA	NA	2.6E-02	5.2E+01	0.0005
Mercury	0.503	NA	Regression	0.265	0.0687	Regression	0.465	0.1920	0.0966	5.3E-03	1.0E+00	0.0052
Molybdenum	35.7	NA	0.25	8.93	125	1	35.7	1	35.7	1.7E+00	2.6E-01	**6.6**
Nickel	425	1.26	Regression	10.0	17.4	1	425	Regression	13.1	1.5E+00	1.7E+00	0.89
Selenium	318	0.970	Regression	294	146	Regression	63.3	Regression	5.77	8.5E-01	1.4E-01	**5.9**
Silver	7.30	NA	0.014	0.102	0.164	2.045	14.9	0.0040	0.0292	2.4E-02	6.0E+00	0.0040
Thallium	2.31	NA	0.0040	0.00924	0.713	1	2.31	0.1124	0.260	1.7E-02	3.7E-03	**4.5**
Uranium	74.4	0.0206	0.0085	0.632	1.27	1	74.4	1	74.4	3.4E+00	3.1E+00	**1.1**
Vanadium	584	0.0885	0.00485	2.83	13.1	0.042	24.5	0.012	7.18	1.1E+00	4.2E+00	0.26
Zinc	1,610	4.73	Regression	289	231	Regression	964	Regression	132	8.8E+00	7.5E+01	0.12

Notes:
BAF_{S-P} - bioaccumulation factor from soil to plants
BAF_{S-I} - bioaccumulation factor from soil to invertebrates
BAF_{S-V} - bioaccumulation factor from soil to terrestrial vertebrates
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
na - not available
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Parameter	Value	Unit
Body Weight:	13.6	kg
Food Ingestion Rate (FIR):	4.2861	kg (dry wt)/day
FIR_Plants (2%):	0.0857	kg (dry wt)/day
FIR_Inverts (2%):	0.0857	kg (dry wt)/day
FIR_Terrestrial Vertebrates (96%):	4.1147	kg (dry wt)/day
FIR_Soil (2.8%):	0.1200	kg (dry wt)/day
Water Ingestion Rate:	1.0371	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	0.1423	unitless
Home range:	7,240	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier I Ecological Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at the Henry Site. The measured plant concentration is equal to the maximum concentration detected in plant tissue collected from Henry Site.

[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 and A4-15.

[c] The plant (C_{PLANT}), terrestrial invertebrate (C_{INVERT}), and terrestrial vertebrate ($C_{VERTEBRATE}$) concentrations were calculated from the soil concentration and the soil-to-biota bioconcentration

[d] The measured plant concentration is equal to the maximum concentration detected in plant tissue collected from Henry Site.

[e] The ingestion dose for the coyote accounts for exposure to soil based upon terrestrial foraging habits as presented in Appendix Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from upland soil.

Table F-10
Tier I Henry Site Ecological Hazard Calculations for the Great Blue Heron

Constituent	EPC [a] C_{RIP_SOIL} (mg/kg)	C_{WATER} (mg/L)	$C_{SEDIMENT}$ (mg/kg)	BAF_{S-I} [b]	EPC C_{INVERT} [c] (mg/kg)	BAF_{S-V} [b]	EPC $C_{VERTEBRATES}$ [c] (mg/kg)	BCF_{Sed-F} [b]	BCF_{W-F} [b]	EPC C_{FISH} [c,d] (mg/kg)	Ingestion Dose [e] (mg/kg-day)	TRV NOAEL mg/kg-day	Ecological Hazard
Aluminum	NA	0.905	NA	NA	NA	NA	NA	1.0	13.5	12.2	6.1E-01	1.1E+02	0.0056
Antimony	7.00	0.00230	8.50	1	7.00	0.05	0.350	1	200	0.460	8.2E-02	na	na
Arsenic	NA	0.0224	10.6	Regression	NA	NA	NA	0.012	570	12.8	6.0E-01	2.2E+00	0.268
Barium	NA	0.0810	NA	NA	NA	NA	NA	1	3,165	256	1.2E+01	2.1E+01	0.58
Boron	5.90	0.121	17.4	1	5.90	1	5.9	1	1	0.121	1.1E-01	2.9E+01	0.0038
Cadmium	67.3	0.0352	104	Regression	235	Regression	2.077	0.785	4,535	160	9.3E+00	1.5E+00	**6.4**
Chromium	467	0.00760	1,030	0.306	143	Regression	21.12	0.0430	95	0.722	1.8E+00	2.7E+00	0.66
Cobalt	NA	0.0141	10.6	NA	NA	NA	NA	1	1	0.0141	1.3E-03	7.6E+00	0.00017
Copper	56.0	0.00379	68.8	0.515	28.8	Regression	13.8	1	3,550	13.5	9.9E-01	4.1E+00	0.24
Manganese	NA	2.44	2,580	Regression	NA	NA	NA	1	1	2.4	1.3E+00	1.8E+02	0.008
Mercury	0.0240	ND	0.236	Regression	0.325	0.192	0.0	0.380	1	0.0897	6.8E-03	4.5E-01	0.015
Molybdenum	14.8	0.0400	10.8	1	14.8	1	14.800	1	1	0.0400	2.4E-01	3.5E+00	0.068
Nickel	251	1.26	1,110	1	251	Regression	10.25	1	390	491	2.5E+01	6.7E+00	**3.8**
Selenium	45.0	0.970	148	Regression	15.1	Regression	2.765	1	645	626	2.9E+01	2.9E-01	**101**
Silver	NA	ND	2.16	2.045	NA	NA	NA	1	439	2.16	1.0E-01	2.0E+00	0.050
Thallium	0.223	0.000348	2.17	1	0.223	0.1124	0.0251	1	50,000	17.4	8.1E-01	3.5E-01	**2.4**
Uranium	1.66	0.0206	90.0	1	1.66	1	1.66	1	1	0.0206	6.7E-02	1.6E+01	0.0042
Vanadium	773	0.0885	940	0.042	32.5	0.0123	9.508	1	1	0.0885	7.4E-01	3.4E-01	**2.2**
Zinc	1,600	4.73	7,940	Regression	962	Regression	132	1.833	10,295	48,695	2.3E+03	6.6E+01	**35**

Notes:

BAF_{S-I} - bioaccumulation factor from soil to terrestrial invertebrates
BAF_{S-V} - bioaccumulation factor from soil to terrestrial vertebrates (birds and mammals)
BAF_{Sed-F} - bioaccumulation factor from sediment to fish
BAF_{W-F} - bioaccumulation factor from water to fish
C_{RIP_SOIL} - Riparian Soil Concentration
$C_{SEDIMENT}$ - Sediment Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
ND - not detected
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	2.336	kg
Food Ingestion Rate (FIR):	0.145	kg (dry wt)/day
FIR_Terrestrial Inverts (12.5%):	0.0182	kg (dry wt)/day
FIR_Terrestrial Vertebrates (12.5%):	0.0182	kg (dry wt)/day
FIR_Upland Soil (0%):	0	kg (dry wt)/day
FIR_Fish (75%):	0.11	kg (dry wt)/day
FIR_Riparian Soil (0%):	0	kg (dry wt)/day
FIR_Sediment (0.7%):	0.00102	kg (dry wt)/day
Water Ingestion Rate:	0.104	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	11	acres

[a] The abiotic media exposure point concentrations used in the Tier I Ecological Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at the Henry Site. Exposure point concentrations are shown for both surface water and sediment for metals that were COPECs in either medium for biota uptake modeling.

[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 through A4-15.

[c] The terrestrial invertebrate (C_{INVERT}), terrestrial vertebrate ($C_{VERTIBRATE}$), and fish (C_{FISH}) concentrations were calculated from the soil, sediment, or surface water concentration and the soil, sediment-, or surface water-to-biota bioconcentration factors.

[d] The aquatic invertebrate EPC is calculated using the sediment to invertebrate BAF for analytes detected in sediment; otherwise the aquatic invertebrate EPC is based on the water to invertebrate BAF. The fish EPC is calculated using the water to fish BAF for analytes detected in surface water; otherwise the fish EPC is based on the sediment to fish BAF.

[e] The ingestion dose for the great blue heron accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16.

Table F-11
Tier I Henry Site Ecological Hazard Calculations for the Northern Harrier

Constituent	EPC [a] C_{UP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	BAF_{S-I} [b]	EPC C_{INVERT} [c] (mg/kg)	BAF_{S-V} [b]	EPC $C_{VERTEBRATES}$ [c] (mg/kg)	Ingestion Dose [d] (mg/kg-day)	TRV NOAEL (mg/kg-day)	Ecological Hazard
Aluminum	NA	0.905	NA	NA	NA	NA	7.0E-02	1.1E+02	0.00063
Antimony	9.15	NA	1	9.150	0.05	0.458	7.5E-02	na	na
Arsenic	45.5	NA	Regression	3.58	Regression	0.179	6.1E-02	2.2E+00	0.027
Barium	NA	0.0810	NA	NA	NA	NA	6.2E-03	2.1E+01	0.00030
Boron	39.0	0.121	1	39.0	1	39.0	4.3E+00	2.9E+01	0.15
Cadmium	59.5	0.0352	Regression	213	Regression	1.96	7.2E-01	1.5E+00	0.49
Chromium	519	NA	0.306	159	Regression	22.8	3.2E+00	2.7E+00	**1.2**
Cobalt	NA	0.0141	NA	NA	NA	NA	1.1E-03	7.6E+00	0.00014
Copper	172	NA	0.515	88.6	Regression	16.2	2.0E+00	4.1E+00	0.50
Manganese	NA	2.44	Regression	NA	NA	NA	1.9E-01	1.8E+02	0.0010
Mercury	0.503	NA	Regression	0.465	0.1920	0.0966	1.2E-02	4.5E-01	0.026
Molybdenum	35.7	NA	1	35.7	1	35.7	3.9E+00	3.5E+00	**1.1**
Nickel	425	1.26	1	425	Regression	13.1	2.7E+00	6.7E+00	0.41
Selenium	318	0.970	Regression	63.3	Regression	5.77	1.1E+00	2.9E-01	**3.7**
Silver	7.30	NA	2.045	14.9	0.0040	0.0292	4.1E-02	2.0E+00	0.020
Thallium	2.31	NA	1	2.31	0.1124	0.260	3.4E-02	3.5E-01	0.099
Uranium	74.4	0.0206	1	74.4	1	74.4	8.1E+00	1.6E+01	0.51
Vanadium	584	0.0885	0.042	24.5	0.0123	7.18	1.3E+00	3.4E-01	**3.7**
Zinc	1,610	4.73	Regression	964	Regression	132	1.8E+01	6.6E+01	0.27

Notes:
BAF_{S-I} - bioaccumulation factor from soil to terrestrial invertebrates
BAF_{S-V} - bioaccumulation factor from soil to terrestrial vertebrates
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	0.449	kg
Food Ingestion Rate (FIR):	0.049	kg (dry wt)/day
FIR_Terrestrial Inverts (2%):	0.00097	kg (dry wt)/day
FIR_Terrestrial Vertebrates (98%):	0.0477	kg (dry wt)/day
FIR_Upland Soil (0.7%):	0.000341	kg (dry wt)/day
Water Ingestion Rate:	0.034	L/day
Exposure Duration (ED):	1.00	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	642	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier I Ecological Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at the Henry Site.
[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 and A4-15.
[c] The terrestrial invertebrate (C_{INVERT}) and terrestrial vertebrate ($C_{VERTIBRATE}$) concentrations were calculated from the soil concentration and the soil-to-biota bioconcentration
[d] The ingestion dose for the northern harrier accounts for exposure to soil based upon terrestrial foraging habits as presented in Appendix A4-13 and A4-15.

ATTACHMENT G – TIER I BACKGROUND ECOLOGICAL HAZARD CALCULATIONS

Table G-1
Tier I Background Ecological Hazard Calculations for the Long-Tailed Vole

Constituent	EPC [a] C_{UP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	$BAF_{S\text{-}P}$ [b]	EPC C_{PLANT} [c] (mg/kg)	Measured Plant Concentration [d] (mg/kg)	Ingestion Dose [e] (mg/kg-day)	TRV NOAEL (mg/kg-day)	Ecological Hazard
Aluminum	NA	0.410	NA	NA	NA	5.6E-02	1.9E+00	0.029
Antimony	3.60	NA	Regression	0.131	5.41	1.7E+00	5.9E-02	**29**
Arsenic	19.0	NA	0.0375	0.713	na	3.6E-01	1.0E+00	0.35
Barium	NA	0.0850	NA	NA	NA	1.2E-02	5.2E+01	0.00023
Boron	25.0	0.0200	4	100	68.3	2.1E+01	2.8E+01	0.76
Cadmium	44.0	0.000100	Regression	4.91	1.95	9.3E-01	7.7E-01	**1.2**
Chromium	420	NA	0.041	17.2	na	8.4E+00	2.4E+00	**3.5**
Copper	82.0	NA	Regression	11.1	na	4.0E+00	5.6E+00	0.72
Manganese	NA	0.0484	0.079	NA	NA	6.7E-03	5.2E+01	0.00013
Mercury	0.320	NA	Regression	0.208	0.0876	2.9E-02	1.0E+00	0.029
Molybdenum	29.0	NA	0.25	7.25	8.91	3.0E+00	2.6E-01	**11**
Nickel	230	0.00221	Regression	6.33	na	3.7E+00	1.7E+00	**2.2**
Selenium	29.0	0.001	Regression	20.9	7.28	2.5E+00	1.4E-01	**17**
Silver	2.40	NA	0.014	0.0336	0.598	2.0E-01	6.0E+00	0.034
Thallium	1.30	NA	0.004	0.00520	0.0257	1.8E-02	3.7E-03	**4.7**
Uranium	42.0	0.00120	0.0085	0.357	0.162	3.6E-01	3.1E+00	0.12
Vanadium	370	0.00620	0.00485	1.79	na	3.3E+00	4.2E+00	0.79
Zinc	1,200	0.0150	Regression	245	na	8.5E+01	7.5E+01	**1.1**

Notes:
$BAF_{S\text{-}P}$ - bioaccumulation factor from soil to plants
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
mg/L - milligrams per liter
NA - not applicable
na - not available
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	0.037	kg
Food Ingestion Rate (FIR):	0.0115	kg (dry wt)/day
FIR_Plants (100%):	0.0115	kg (dry wt)/day
FIR_Soil (2.4%):	0.00028	kg (dry wt)/day
Water Ingestion Rate:	0.0051	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	0.066	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier I Background Ecological Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at background locations.
[b] The soil-to-plant bioconcentration factor was derived from sources listed in Table A4-13 and A4-15.
[c] The plant concentration (C_{PLANT}) was calculated from the upland soil concentration and the soil-to-plant bioconcentration factor ($BCF_{S\text{-}P}$).
[d] The measured plant concentration is equal to the maximum concentration detected in plant tissue collected from background locations.
[e] The ingestion dose for the long-tailed vole accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from upland soil.

Table G-2
Tier I Background Ecological Hazard Calculations for Elk

Constituent	EPC [a] C_{UP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	BAF_{S-P} [b]	EPC C_{PLANT} [c] (mg/kg)	Measured Plant Concentration [d] (mg/kg)	Ingestion Dose [e] (mg/kg-day)	TRV NOAEL (mg/kg-day)	Ecological Hazard
Aluminum	NA	0.410	NA	NA	NA	1.4E-03	1.9E+00	0.00074
Antimony	3.60	NA	Regression	0.131	5.41	2.7E-03	5.9E-02	0.046
Arsenic	19.0	NA	0.0375	0.713	na	5.4E-04	1.0E+00	0.00052
Barium	NA	0.0850	NA	NA	NA	3.0E-04	5.2E+01	0.0000057
Boron	25.0	0.0200	4.0	100	68.3	3.4E-02	2.8E+01	0.0012
Cadmium	44.0	0.000100	Regression	4.91	1.95	1.4E-03	7.7E-01	0.0018
Chromium	420	NA	0.041	17.2	na	1.3E-02	2.4E+00	0.0053
Copper	82.0	NA	Regression	11.1	na	6.3E-03	5.6E+00	0.0011
Manganese	NA	0.0484	0.079	NA	NA	1.7E-04	5.2E+01	0.0000033
Mercury	0.320	NA	Regression	0.208	0.0876	4.7E-05	1.0E+00	0.000046
Molybdenum	29.0	NA	0.25	7.25	8.91	4.7E-03	2.6E-01	0.018
Nickel	230	0.00221	Regression	6.33	na	5.4E-03	1.7E+00	0.0032
Selenium	29.0	0.00100	Regression	20.9	7.28	3.9E-03	1.4E-01	0.027
Silver	2.40	NA	0.014	0.0336	0.598	3.2E-04	6.0E+00	0.000053
Thallium	1.30	NA	0.004	0.00520	0.0257	2.6E-05	3.7E-03	0.0069
Uranium	42.0	0.00120	0.0085	0.357	0.162	5.0E-04	3.1E+00	0.00016
Vanadium	370	0.00620	0.00485	1.79	na	4.6E-03	4.2E+00	0.0011
Zinc	1,200	0.0150	Regression	245	na	1.3E-01	7.5E+01	0.0018

Notes:

BAF_{S-P} - bioaccumulation factor from soil to plants
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
mg/L - milligrams per liter
NA - not applicable
na - not available
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	286	kg
Food Ingestion Rate (FIR):	2.29	kg (dry wt)/day
FIR_Plants (100%):	2.29	kg (dry wt)/day
FIR_Soil (2%):	0.0459	kg (dry wt)/day
Water Ingestion Rate:	16.1	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	0.0619	unitless
Home range:	16,640	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier I Background Ecological Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at background locations.
[b] The soil-to-plant bioconcentration factor was derived from sources listed in Table A4-13 and A4-15.
[c] The plant concentration (C_{PLANT}) was calculated from the upland soil concentration and the soil-to-plant bioconcentration factor (BCF_{S-P}).
[d] The measured plant concentration is equal to the maximum concentration detected in plant tissue collected from background locations.
[e] The ingestion dose for the elk accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from upland soil.

Table G-3
Tier I Background Ecological Hazard Calculations for the American Goldfinch

Constituent	EPC [a] C_{UP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	BAF_{S-P} [b]	EPC C_{PLANT} [c] (mg/kg)	Measured Plant Concentration [d] (mg/kg)	Ingestion Dose [e] (mg/kg-day)	TRV NOAEL (mg/kg-day)	Ecological Hazard
Aluminum	NA	0.410	NA	NA	NA	9.6E-02	1.1E+02	0.00087
Antimony	3.60	NA	Regression	0.131	5.41	1.5E+00	na	na
Arsenic	19.0	NA	0.0375	0.713	na	7.1E-01	2.2E+00	0.32
Barium	NA	0.0850	NA	NA	NA	2.0E-02	2.1E+01	0.00095
Boron	25.0	0.0200	4.0	100	68.3	1.9E+01	2.9E+01	0.65
Cadmium	44.0	0.000100	Regression	4.91	1.95	1.7E+00	1.5E+00	**1.2**
Chromium	420	NA	0.041	17.2	na	1.6E+01	2.7E+00	**6.0**
Copper	82.0	NA	Regression	11.1	na	5.2E+00	4.1E+00	**1.3**
Manganese	NA	0.0484	0.079	NA	NA	1.1E-02	1.8E+02	0.000063
Mercury	0.320	NA	Regression	0.208	0.0876	3.2E-02	4.5E-01	0.071
Molybdenum	29.0	NA	0.25	7.25	8.91	3.2E+00	3.5E+00	0.90
Nickel	230	0.00221	Regression	6.33	na	8.0E+00	6.7E+00	**1.2**
Selenium	29.0	0.00100	Regression	20.9	7.28	2.7E+00	2.9E-01	**9.4**
Silver	2.40	NA	0.014	0.0336	0.598	2.2E-01	2.0E+00	0.11
Thallium	1.30	NA	0.004	0.00520	0.0257	4.3E-02	3.5E-01	0.12
Uranium	42.0	0.00120	0.0085	0.357	0.162	1.2E+00	1.6E+01	0.075
Vanadium	370	0.00620	0.00485	1.79	na	1.1E+01	3.4E-01	**31**
Zinc	1,200	0.0150	Regression	245	na	9.8E+01	6.6E+01	**1.5**

Notes:
BAF_{S-P} - bioaccumulation factor from soil to plants
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
mg/L - milligrams per liter
NA - not applicable
na - not available
NOAEL - no observed adverse effect
TRV - toxicity reference value

Exposure Parameters

Body Weight:	0.0155	kg
Food Ingestion Rate (FIR):	0.0041	kg (dry wt)/day
FIR_Plants (100%):	0.0041	kg (dry wt)/day
FIR_Soil (10.4%):	0.000426	kg (dry wt)/day
Water Ingestion Rate:	0.00362	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	0.119	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier I Background Ecological Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at background locations.

[b] The soil-to-plant bioconcentration factor was derived from sources listed in Table A4-13 and A4-15.

[c] The plant concentration (C_{PLANT}) was calculated from the upland soil concentration and the soil-to-plant bioconcentration factor (BCF_{S-P}).

[d] The measured plant concentration is equal to the maximum concentration detected in plant tissue collected from background locations.

[e] The ingestion dose for the American goldfinch accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from upland soil.

Table G-4
Tier I Background Ecological Hazard Calculations for the Deer Mouse

Constituent	EPC [a] C_{UP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	$BAF_{S\text{-}P}$ [b]	EPC C_{PLANT} [c] (mg/kg)	Measured Plant Concentration [d] (mg/kg)	$BAF_{S\text{-}I}$ [b]	EPC C_{INVERT} [c] (mg/kg)	Ingestion Dose [e] (mg/kg-day)	TRV NOAEL (mg/kg-day)	Ecological Hazard
Aluminum	NA	0.410	NA	NA	NA	NA	NA	6.0E-02	1.9E+00	0.031
Antimony	3.60	NA	Regression	0.131	5.41	1	3.600	9.3E-01	5.9E-02	**16**
Arsenic	19.0	NA	0.0375	0.713	na	Regression	1.93	3.1E-01	1.0E+00	0.29
Barium	NA	0.0850	NA	NA	NA	NA	NA	1.2E-02	5.2E+01	0.00024
Boron	25.0	0.0200	4.0	100	68.3	1	25.0	1.0E+01	2.8E+01	0.36
Cadmium	44.0	0.000100	Regression	4.91	1.95	Regression	167.7	1.3E+01	7.7E-01	**17**
Chromium	420	NA	0.041	17.2	na	0.306	128.52	1.3E+01	2.4E+00	**5.6**
Copper	82.0	NA	Regression	11.1	na	0.515	42.2	4.8E+00	5.6E+00	0.86
Manganese	NA	0.0484	0.079	NA	NA	Regression	NA	7.1E-03	5.2E+01	0.00014
Mercury	0.320	NA	Regression	0.208	0.0876	Regression	0.441	4.5E-02	1.0E+00	0.045
Molybdenum	29.0	NA	0.25	7.25	8.91	1	29.00	3.4E+00	2.6E-01	**13**
Nickel	230	0.00221	Regression	6.33	na	1	230.0	1.9E+01	1.7E+00	**11**
Selenium	29.0	0.00100	Regression	20.9	7.28	Regression	10.95	1.8E+00	1.4E-01	**13**
Silver	2.40	NA	0.014	0.0336	0.598	2.045	4.908	4.5E-01	6.0E+00	0.075
Thallium	1.30	NA	0.0040	0.00520	0.0257	1	1.300	1.1E-01	3.7E-03	**29**
Uranium	42.0	0.00120	0.0085	0.357	0.162	1	42.00	3.3E+00	3.1E+00	**1.1**
Vanadium	370	0.00620	0.00485	1.79	na	0.042	15.54	2.8E+00	4.2E+00	0.68
Zinc	1,200	0.0150	Regression	245	na	Regression	875	1.0E+02	7.5E+01	**1.3**

Notes:

$BAF_{S\text{-}I}$ - bioaccumulation factor from soil to invertebrates
$BAF_{S\text{-}P}$ - bioaccumulation factor from soil to plants
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day

NA - not applicable
na - not available
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	0.0195	kg
Food Ingestion Rate (FIR):	0.0038	kg (dry wt)/day
FIR_Plants (61.5%):	0.0023	kg (dry wt)/day
FIR_Inverts (38.5%):	0.0015	kg (dry wt)/day
FIR_Soil (2%):	0.0001	kg (dry wt)/day
Water Ingestion Rate:	0.0029	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	0.27	acres

[a] The abiotic media exposure point concentrations used in the Tier I Background Ecological Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at background locations.

[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 and A4-15.

[c] The plant (C_{PLANT}) and terrestrial invertebrate (C_{INVERT}) concentrations were calculated from upland soil concentration and the soil-to-biota bioconcentration factors ($BCF_{S\text{-}P}$ and $BCF_{S\text{-}I}$).

[d] The measured plant concentration is equal to the maximum concentration detected in plant tissue collected from background locations.

[e] The ingestion dose for the deer mouse accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from upland soil.

Table G-5
Tier I Background Ecological Hazard Calculations for the Raccoon

	EPC [a]			BAF_{S-P} [b]	EPC	Measured Plant	BAF_{S-I} [b]	EPC	BAF_{S-V} [b]	EPC	BAF_{Sed-I} [b]	BAF_{W-I} [b]	EPC	BCF_{Sed-F} [b]	BCF_{W-F} [b]	EPC	Ingestion	TRV	Ecological
	C_{RIP_SOIL}	C_{WATER}	$C_{SEDIMENT}$		C_{PLANT} [c]	Concentration [d]		C_{INVERT} [c]		$C_{VERTEBRATES}$ [c]			$C_{AQ\ INVERT}$ [c, e]			C_{FISH} [c, e]	Dose [f]	NOAEL	Hazard
Constituent	**(mg/kg)**	**(mg/L)**	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**		**(mg/kg)**		**(mg/kg)**			**(mg/kg)**			**(mg/kg)**	**(mg/kg-day)**	**(mg/kg-day)**	
Aluminum	NA	0.410	NA	NA	NA	NA	NA	NA	NA	NA	NA	24,355	9,986	1	13.5	5.54	8.4E+00	1.9E+00	**4.4**
Antimony	5.50	NA	5.00	Regression	0.195	na	1	5.50	0.05	0.275	1	NA	5.00	1	200	5.00	2.5E-02	5.9E-02	0.43
Arsenic	NA	0.00110	4.55	NA	NA	NA	NA	NA	NA	NA	Regression	437	1.60	0.012	570	0.627	1.4E-03	1.0E+00	0.0014
Barium	NA	0.0850	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,198	102	1	3,165	269	1.2E-01	5.2E+01	0.0023
Boron	11.2	0.0200	8.40	4.0	44.8	na	1	11.2	1	11.2	1	1	8.40	1	1	0.0200	4.0E-01	2.8E+01	0.014
Cadmium	4.40	0.000100	3.74	Regression	1.40	0.900	Regression	26.9	Regression	0.573	Regression	20,731	2.73	0.785	4,535	0.454	7.6E-02	7.7E-01	0.099
Chromium	42.5	0.00393	34.8	0.041	1.74	na	0.306	13.0	Regression	3.64	Regression	17970.0	5.91	0.043	95.00	0.373	1.0E-01	2.4E+00	0.042
Copper	21.1	ND	25.5	Regression	6.48	na	0.515	10.9	Regression	12.0	Regression	22,271	30.2	1	3,550	25.5	1.4E-01	5.6E+00	0.025
Manganese	NA	0.0484	405	NA	NA	NA	NA	NA	NA	NA	Regression	1	26.7	1	1	0.0484	2.4E-02	5.2E+01	0.00047
Mercury	0.0690	NA	0.0380	Regression	0.091	na	Regression	0.368	0.192	0.0132	Regression	NA	0.0734	0.38	1	0.0144	1.7E-03	1.0E+00	0.0017
Molybdenum	0.700	ND	ND	0.25	0.175	2.58	1	0.700	1	0.700	1	1	NA	1	1	NA	2.3E-02	2.6E-01	0.088
Nickel	26.6	0.00221	24.4	Regression	1.26	na	1	26.6	Regression	3.60	Regression	168	7.77	1	390	0.862	1.1E-01	1.7E+00	0.065
Selenium	1.80	0.00100	1.60	Regression	0.972	0.800	Regression	1.43	Regression	0.823	Regression	7559.4	1.31	1	645	0.65	1.4E-02	1.4E-01	0.095
Silver	NA	ND	0.241	NA	NA	NA	NA	NA	NA	NA	2.045	1,785	0.493	1	439	0.241	4.4E-04	6.0E+00	0.000074
Thallium	0.428	0.000150	0.378	0.0040	0.00171	na	1	0.428	0.1124	0.0481	1	89,850	0.378	1	50,000	7.50	2.7E-03	3.7E-03	0.74
Uranium	3.76	0.00120	2.37	0.0085	0.0320	na	1	3.76	1	3.76	1	1	2.37	1	1	0.00120	1.9E-02	3.1E+00	0.0063
Vanadium	57.3	0.00620	45.2	0.00485	0.278	na	0.042	2.41	0.012	0.705	0.042	1	1.90	1	1	0.00620	7.5E-02	4.2E+00	0.018
Zinc	158	0.0150	151	Regression	79.8	na	Regression	450	Regression	112	Regression	27,422	179	1.833	10,295	154	2.1E+00	7.5E+01	0.028

Notes:
BAF_{S-I} - bioaccumulation factor from soil to invertebrates
BAF_{S-P} - bioaccumulation factor from soil to plants
BAF_{S-V} - bioaccumulation factor from soil to terrestrial vertebrates
BAF_{Sed-F} - bioaccumulation factor from sediment to fish
BAF_{Sed-I} - bioaccumulation factor from sediment to aquatic invertebrates
BAF_{W-F} - bioaccumulation factor from water to fish
BAF_{W-I} - bioaccumulation factor from water to aquatic invertebrates
C_{FISH} - Fish Concentration
C_{RIP_SOIL} - Riparian Soil Concentration
$C_{SEDIMENT}$ - Sediment Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
na - not available
ND - not detected
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters		
Body Weight:	5.8	kg
Food Ingestion Rate (FIR):	0.154	kg (dry wt)/day
FIR_Terrestrial Plants (64%):	0.0985	kg (dry wt)/day
FIR_Terrestrial Inverts (19%):	0.0292	kg (dry wt)/day
FIR_Terrestrial Vertebrates (9%):	0.0138	kg (dry wt)/day
FIR_Upland Soil (0%):	0	kg (dry wt)/day
FIR_Aquatic Plants (0%):	0	kg (dry wt)/day
FIR_Aquatic Inverts (7%):	0.0108	kg (dry wt)/day
FIR_Fish (1%):	0.0015	kg (dry wt)/day
FIR_Riparian Soil (9.4%):	0.0145	kg (dry wt)/day
Water Ingestion Rate:	0.4816	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	0.453	unitless
Home range:	2,272	acres
Exposure area:	1030	acres

[a] The abiotic media exposure point concentrations used in the Tier I Background Ecological Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at background locations. Exposure point concentrations are shown for both surface water and sediment for metals that were COPECs in either medium for biota uptake modeling.

[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 through A4-15.

[c] The terrestrial plant (C_{PLANT}), terrestrial invertebrate (C_{INVERT}), terrestrial vertebrate ($C_{VERTIBRATE}$), aquatic invertebrate ($C_{AQ\ INVERT}$), and fish (C_{FISH}) concentrations were calculated from the soil, sediment, or surface water concentration and the soil-, sediment-, or surface water-to-biota bioaccumulation factors.

[d] The measured plant concentration is equal to the maximum concentration detected in plant tissue collected from background locations.

[e] The aquatic invertebrate EPC is calculated using the sediment to invertebrate BAF for analytes detected in sediment; otherwise the aquatic invertebrate EPC is based on the water to invertebrate BAF. The fish EPC is calculated using the water to fish BAF for analytes detected in surface water; otherwise the fish EPC is based on the sediment to fish BAF.

[f] The ingestion dose for the raccoon accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from riparian soil.

Table G-6
Tier I Background Ecological Hazard Calculations for the American Robin

Constituent	EPC [a] C_{UP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	BAF_{S-P} [b]	EPC C_{PLANT} [c] (mg/kg)	Measured Plant Concentration [d] (mg/kg)	BAF_{S-I} [b]	EPC C_{INVERT} [c] (mg/kg)	Ingestion Dose [e] (mg/kg-day)	TRV NOAEL (mg/kg-day)	Ecological Hazard
Aluminum	NA	0.410	NA	NA	NA	NA	NA	5.5E-02	1.1E+02	0.00050
Antimony	3.60	NA	Regression	0.131	5.41	1	3.60	6.2E-01	na	na
Arsenic	19.0	NA	0.0375	0.713	na	Regression	1.93	4.4E-01	2.2E+00	0.19
Barium	NA	0.0850	NA	NA	NA	NA	NA	1.1E-02	2.1E+01	0.00055
Boron	25.0	0.0200	4.0	100	68.3	1	25.0	6.1E+00	2.9E+01	0.21
Cadmium	44.0	0.000100	Regression	4.91	1.95	Regression	168	1.3E+01	1.5E+00	**8.7**
Chromium	420	NA	0.041	17.2	na	0.306	129	1.6E+01	2.7E+00	**6.0**
Copper	82.0	NA	Regression	11.1	na	0.515	42.2	4.8E+00	4.1E+00	**1.2**
Manganese	NA	0.0484	0.079	NA	NA	Regression	NA	6.5E-03	1.8E+02	0.000036
Mercury	0.320	NA	Regression	0.208	0.0876	Regression	0.441	4.1E-02	4.5E-01	0.091
Molybdenum	29.0	NA	0.25	7.25	8.91	1	29.0	3.0E+00	3.5E+00	0.85
Nickel	230	0.00221	Regression	6.33	na	1	230	2.0E+01	6.7E+00	**3.0**
Selenium	29.0	0.00100	Regression	20.9	7.28	Regression	10.9	1.6E+00	2.9E-01	**5.5**
Silver	2.40	NA	0.014	0.0336	0.598	2.045	4.91	4.2E-01	2.0E+00	0.21
Thallium	1.30	NA	0.0040	0.00520	0.0257	1	1.30	1.1E-01	3.5E-01	0.32
Uranium	42.0	0.00120	0.0085	0.357	0.162	1	42.0	3.6E+00	1.6E+01	0.22
Vanadium	370	0.00620	0.00485	1.79	na	0.042	15.5	6.2E+00	3.4E-01	**18**
Zinc	1,200	0.0150	Regression	245	na	Regression	875	9.3E+01	6.6E+01	**1.4**

Notes:
BAF_{S-I} - bioaccumulation factor from soil to invertebrates
BAF_{S-P} - bioaccumulation factor from soil to plants
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day

NA - not applicable
na - not available
ND - not detected
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	0.08195	kg
Food Ingestion Rate (FIR):	0.0106	kg (dry wt)/day
FIR_Plants (44.7%):	0.0047	kg (dry wt)/day
FIR_Inverts (55.3%):	0.0059	kg (dry wt)/day
FIR_Soil (10.4%):	0.0011	kg (dry wt)/day
Water Ingestion Rate:	0.0110	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	0.72	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier I Background Ecological Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at background locations.
[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 and A4-15.
[c] The plant (C_{PLANT}) and terrestrial invertebrate (C_{INVERT}) concentrations were calculated from upland soil concentration and the soil-to-biota bioconcentration factors (BCF_{S-P} and BCF_{S-I}).
[d] The measured plant concentration is equal to the maximum concentration detected in plant tissue collected from background locations.
[e] The ingestion dose for the American robin accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from upland soil.

Table G-7
Tier I Background Ecological Hazard Calculations for the Mallard

Constituent	EPC[a] C_{WATER} (mg/L)	EPC[a] $C_{SEDIMENT}$ (mg/kg)	BAF_{Sed-P} [b]	BAF_{W-P} [b]	EPC $C_{AQ\ PLANT}$ [c] (mg/kg)	BAF_{Sed-I} [b]	BAF_{W-I} [b]	EPC $C_{AQ\ INVERT}$ [c] (mg/kg)	Ingestion Dose [d] (mg/kg-day)	TRV NOAEL (mg/kg-day)	Ecological Hazard
Aluminum	0.410	NA	NA	2,432	997	NA	24,355	9,986	3.5E+02	1.1E+02	**3.2**
Antimony	NA	5.00	Regression	4,307	0.178	1	42	5.00	1.8E-01	na	na
Arsenic	0.00110	4.55	0.0375	856	0.171	Regression	437	1.60	6.4E-02	2.2E+00	0.028
Barium	0.0850	NA	NA	759	64.5	NA	1,198	102	4.3E+00	2.1E+01	0.20
Boron	0.0200	8.40	4	1	33.6	1	1	8.40	6.9E-01	2.9E+01	0.024
Cadmium	0.000100	3.74	Regression	2,283	1.28	Regression	20,731	2.73	1.1E-01	1.5E+00	0.078
Chromium	0.00393	34.8	0.041	12,866	1.43	Regression	17,970	5.91	2.7E-01	2.7E+00	0.10
Copper	ND	25.5	Regression	1,580	6.99	Regression	22,271	30.2	1.2E+00	4.1E+00	0.29
Manganese	0.0484	405	0.079	1	32.0	Regression	1	119	5.1E+00	1.8E+02	0.028
Mercury	NA	0.0380	Regression	1	0.0660	Regression	1	0.0734	3.3E-03	4.5E-01	0.0074
Nickel	0.00221	24.4	Regression	178	1.18	Regression	168	7.77	3.2E-01	6.7E+00	0.047
Selenium	0.00100	1.60	Regression	5,387	0.854	Regression	7,559	2.94	1.1E-01	2.9E-01	0.39
Silver	ND	0.241	0.014	31,232	0.00337	2.045	1,785	0.493	1.7E-02	2.0E+00	0.0086
Thallium	0.000150	0.378	0.004	43,800	0.00151	1	89,850	0.378	1.4E-02	3.5E-01	0.039
Uranium	0.00120	2.37	0.0085	1	0.0201	1	1	2.37	8.5E-02	1.6E+01	0.0053
Vanadium	0.00620	45.2	0.00485	1	0.219	0.042	1	1.90	1.4E-01	3.4E-01	0.40
Zinc	0.0150	151	Regression	6,351	77.8	Regression	27,422	179	7.3E+00	6.6E+01	0.11

Notes:

BAF_{Sed-I} - bioaccumulation factor from sediment to aquatic invertebrates
BAF_{Sed-P} - bioaccumulation factor from sediment to aquatic plants
BCF_{W-I} - bioaccumulation factor from water to aquatic invertebrates
BCF_{W-P} - bioaccumulation factor from water to aquatic plants
$C_{SEDIMENT}$ - Sediment Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
ND - not detected
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	1.178	kg
Food Ingestion Rate (FIR):	0.056	kg (dry wt)/day
FIR_Aquatic Plants (25%):	0.01	kg (dry wt)/day
FIR_Aquatic Inverts (75%):	0.0422	kg (dry wt)/day
FIR_Sediment (3.3%):	0.0019	kg (dry wt)/day
Water Ingestion Rate:	0.066	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	0.959	unitless
Home range:	1,074	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier I Background Ecological Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at background locations. The measured plant concentration is equal to the maximum concentration detected in plant tissue collected from background locations. Exposure point concentrations are shown for both surface water and sediment for metals that were COPECs in either medium for biota uptake modeling.

[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-14 and A4-15.

[c] The aquatic plant ($C_{AQ\ PLANT}$) and aquatic invertebrate ($C_{AQ\ INVERT}$) concentrations were calculated from the sediment concentration and the sediment-to-biota bioaccumulation factors.

[d] The ingestion dose for the mallard accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16.

Table G-8
Tier I Background Ecological Hazard Calculations for the Mink

	EPC [a]				EPC			EPC			EPC	Ingestion	TRV	Ecological
	C_{RIP_SOIL}	C_{WATER}	$C_{SEDIMENT}$	BAF_{S-V} [b]	$C_{VERTEBRATES}$ [c]	BAF_{Sed-I} [b]	BAF_{W-I} [b]	$C_{AQ\ INVERT}$ [c,d]	BCF_{Sed-F} [b]	BCF_{W-F} [b]	C_{FISH} [c,d]	Dose [e]	NOAEL	Hazard
Constituent	**(mg/kg)**	**(mg/L)**	**(mg/kg)**		**(mg/kg)**			**(mg/kg)**			**(mg/kg)**	**(mg/kg-day)**	**(mg/kg-day)**	
Aluminum	NA	0.410	NA	NA	NA	NA	24,355	9,986	1	13.5	5.54	2.9E+02	1.9E+00	**149**
Antimony	5.50	NA	5.00	0.05	0.275	1	NA	5.00	1	200	5.00	1.2E+00	5.9E-02	**21**
Arsenic	NA	0.00110	4.55	NA	NA	Regression	437	1.60	0.0120	570	0.627	1.4E-01	1.0E+00	0.13
Barium	NA	0.0850	NA	NA	NA	NA	1,198	102	1	3,165	269	4.3E+01	5.2E+01	0.83
Boron	11.2	0.0200	8.40	1	11.200	1	1	8.40	1	1	0.0200	4.1E+00	2.8E+01	0.15
Cadmium	4.40	0.000100	3.74	Regression	0.573	Regression	20,731	2.73	0.785	4,535	0.454	5.2E-01	7.7E-01	0.67
Chromium	42.5	0.00393	34.8	Regression	3.638	Regression	17,970	5.91	0.0430	95	0.373	3.2E+00	2.4E+00	**1.4**
Copper	21.1	ND	25.5	Regression	11.969	Regression	22,271	30.2	1	3,550.0	25.5	9.2E+00	5.6E+00	**1.6**
Manganese	NA	0.0484	405	NA	NA	Regression	1	26.7	1	1	0.0484	7.8E-01	5.2E+01	0.015
Mercury	0.0690	NA	0.0380	0.192	0.0132	Regression	NA	0.0734	0.380	1	0.0144	1.1E-02	1.0E+00	0.011
Molybdenum	0.700	ND	ND	1	0.700	1	1	NA	1	1	NA	2.4E-01	2.6E-01	0.94
Nickel	26.6	0.00221	24.4	Regression	3.604	Regression	168	7.77	1	390	0.862	2.6E+00	1.7E+00	**1.6**
Selenium	1.80	0.00100	1.60	Regression	0.823	Regression	7,559	1.31	1	645	0.65	4.6E-01	1.4E-01	**3.2**
Silver	NA	ND	0.241	NA	NA	2.045	1,785	0.493	1	438.6	0.241	5.0E-02	6.0E+00	0.0083
Thallium	0.428	0.000150	0.378	0.1124	0.048	1	89,850	0.378	1	50,000	7.50	1.2E+00	3.7E-03	**314**
Uranium	3.76	0.00120	2.37	1	3.760	1	1	2.37	1	1	0.00120	1.4E+00	3.1E+00	0.45
Vanadium	57.3	0.00620	45.2	0.012	0.705	0.042	1	1.90	1	1	0.00620	2.9E+00	4.2E+00	0.69
Zinc	158	0.0150	151	Regression	112.238	Regression	27,422	179	1.83	10,295	154	6.9E+01	7.5E+01	0.92

Notes:

BAF_{S-V} - bioaccumulation factor from soil to terrestrial vertebrates
BAF_{Sed-I} - bioaccumulation factor from sediment to aquatic invertebrates
BAF_{Sed-F} - bioaccumulation factor from sediment to fish
BAF_{W-I} - bioaccumulation factor from water to aquatic invertebrates
BAF_{W-F} - bioaccumulation factor from water to fish
C_{FISH} - Fish Concentration
C_{RIP_SOIL} - Riparian Soil Concentration
$C_{SEDIMENT}$ - Sediment Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
ND - not detected
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	1.075	kg
Food Ingestion Rate (FIR):	0.516	kg (dry wt)/day
FIR_Terrestrial Vertebrates (63%):	0.3252	kg (dry wt)/day
FIR_Upland Soil (0%):	0	kg (dry wt)/day
FIR_Aquatic Inverts (6%):	0.0309	kg (dry wt)/day
FIR_Fish (31%):	0.16	kg (dry wt)/day
FIR_Riparian Soil (9.4%):	0.0485	kg (dry wt)/day
Water Ingestion Rate:	0.106	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	50	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier I Background Ecological Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at background locations. Exposure point concentrations are shown for both surface water and sediment for metals that were COPECs in either medium for biota uptake modeling.

[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 through A4-15.

[c] The aquatic invertebrate ($C_{AQ\ INVERT}$), fish (C_{FISH}), and terrestrial vertebrate ($C_{VERTIBRATE}$) concentrations were calculated from the soil, sediment, or surface water concentration and the soil-, sediment-, or surface water-to-biota

[d] The aquatic invertebrate EPC is calculated using the sediment to invertebrate BAF for analytes detected in sediment; otherwise the aquatic invertebrate EPC is based on the water to invertebrate BAF. The fish EPC is calculated using the water to fish BAF for analytes detected in surface water; otherwise the fish EPC is based on the sediment to fish BAF.

[e] The ingestion dose for the mink accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16.

Table G-9
Tier I Background Ecological Hazard Calculations for the Coyote

Constituent	EPC [a] C_{UP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	BAF_{S-P} [b]	EPC C_{PLANT} [c] (mg/kg)	Measured Plant Concentration [d] (mg/kg)	BAF_{S-I} [b]	EPC C_{INVERT} [c] (mg/kg)	BAF_{S-V} [b]	EPC $C_{VERTEBRATE}$ [c] (mg/kg)	Ingestion Dose [e] (mg/kg-day)	TRV NOAEL (mg/kg-day)	Ecological Hazard
Aluminum	NA	0.410	NA	NA	NA	NA	NA	NA	NA	4.4E-03	1.9E+00	0.0023
Antimony	3.60	NA	Regression	0.131	5.41	1	3.60	0.05	0.180	2.0E-02	5.9E-02	0.34
Arsenic	19.0	NA	0.0375	0.713	na	Regression	1.93	Regression	0.0875	3.0E-02	1.0E+00	0.029
Barium	NA	0.0850	NA	NA	NA	NA	NA	NA	NA	9.2E-04	5.2E+01	0.000018
Boron	25.0	0.0200	4.0	100	68.3	1	25.0	1	25.0	1.2E+00	2.8E+01	0.043
Cadmium	44.0	0.000100	Regression	4.91	1.95	Regression	168	Regression	1.70	2.8E-01	7.7E-01	0.36
Chromium	420	NA	0.041	17.2	na	0.306	129	Regression	19.5	1.5E+00	2.4E+00	0.62
Copper	82.0	NA	Regression	11.1	na	0.515	42.2	Regression	14.6	7.8E-01	5.6E+00	0.14
Manganese	NA	0.0484	0.079	NA	NA	NA	NA	NA	NA	5.3E-04	5.2E+01	0.000010
Mercury	0.320	NA	Regression	0.208	0.0876	Regression	0.441	0.1920	0.0614	3.5E-03	1.0E+00	0.0035
Molybdenum	29.0	NA	0.25	7.25	8.91	1	29.0	1	29.0	1.3E+00	2.6E-01	**5.1**
Nickel	230	0.00221	Regression	6.33	na	1	230	Regression	9.84	9.2E-01	1.7E+00	0.54
Selenium	29.0	0.00100	Regression	20.9	7.28	Regression	10.9	Regression	2.34	1.5E-01	1.4E-01	**1.1**
Silver	2.40	NA	0.014	0.0336	0.598	2.045	4.91	0.0040	0.00960	8.4E-03	6.0E+00	0.0014
Thallium	1.30	NA	0.0040	0.00520	0.0257	1	1.30	0.1124	0.146	9.1E-03	3.7E-03	**2.5**
Uranium	42.0	0.00120	0.0085	0.357	0.162	1	42.0	1	42.0	1.9E+00	3.1E+00	0.62
Vanadium	370	0.00620	0.00485	1.79	na	0.042	15.5	0.012	4.55	6.8E-01	4.2E+00	0.16
Zinc	1,200	0.0150	Regression	245	na	Regression	875	Regression	130	8.1E+00	7.5E+01	0.11

Notes:
BAF_{S-P} - bioaccumulation factor from soil to plants
BAF_{S-I} - bioaccumulation factor from soil to invertebrates
BAF_{S-V} - bioaccumulation factor from soil to terrestrial vertebrates
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
na - not available
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	13.6	kg
Food Ingestion Rate (FIR):	4.2861	kg (dry wt)/day
FIR_Plants (2%):	0.0857	kg (dry wt)/day
FIR_Inverts (2%):	0.0857	kg (dry wt)/day
FIR_Terrestrial Vertebrates (96%):	4.1147	kg (dry wt)/day
FIR_Soil (2.8%):	0.1200	kg (dry wt)/day
Water Ingestion Rate:	1.0371	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	0.1423	unitless
Home range:	7,240	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier I Background Ecological Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at background locations. The measured plant concentration is equal to the maximum concentration detected in plant tissue collected from background locations.

[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 and A4-15.

[c] The plant (C_{PLANT}), terrestrial invertebrate (C_{INVERT}), and terrestrial vertebrate ($C_{VERTEBRATE}$) concentrations were calculated from the soil concentration and the soil-to-biota bioconcentration factors.

[d] The measured plant concentration is equal to the maximum concentration detected in plant tissue collected from background locations.

[e] The ingestion dose for the coyote accounts for exposure to soil based upon terrestrial foraging habits as presented in Appendix Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from upland soil.

Table G-10
Tier I Background Ecological Hazard Calculations for the Great Blue Heron

	EPC [a]			BAF_{S-I} [b]	EPC	BAF_{S-V} [b]	EPC	BCF_{Sed-F} [b]	BCF_{W-F} [b]	EPC	Ingestion	TRV	Ecological
	C_{RIP_SOIL}	C_{WATER}	$C_{SEDIMENT}$		C_{INVERT} [c]		$C_{VERTEBRATES}$ [c]			C_{FISH} [c,d]	Dose [e]	NOAEL	Hazard
Constituent	(mg/kg)	(mg/L)	(mg/kg)		(mg/kg)		(mg/kg)			(mg/kg)	(mg/kg-day)	mg/kg-day	
Aluminum	NA	0.410	NA	NA	NA	NA	NA	1.0	13.5	5.54	2.8E-01	1.1E+02	0.0025
Antimony	5.50	NA	5.00	1	5.50	0.05	0.275	1	200	5.00	2.8E-01	na	na
Arsenic	NA	0.00110	4.55	Regression	NA	NA	NA	0.012	570	0.627	3.1E-02	2.2E+00	0.014
Barium	NA	0.0850	NA	NA	NA	NA	NA	1	3,165	269	1.3E+01	2.1E+01	0.60
Boron	11.2	0.0200	8.40	1	11.2	1	11.2	1	1	0.0200	1.8E-01	2.9E+01	0.0062
Cadmium	4.40	0.000100	3.74	Regression	26.9	Regression	0.573	0.785	4,535	0.454	2.4E-01	1.5E+00	0.16
Chromium	42.5	0.00393	34.8	0.306	13.0	Regression	3.64	0.0430	95	0.373	1.6E-01	2.7E+00	0.061
Copper	21.1	ND	25.5	0.515	10.9	Regression	12.0	1	3,550	25.5	1.4E+00	4.1E+00	0.34
Manganese	NA	0.0484	405	Regression	NA	NA	NA	1	1	0.0484	1.8E-01	1.8E+02	0.0010
Mercury	0.0690	NA	0.0380	Regression	0	0.192	0.0132	0.380	1	0.0144	3.7E-03	4.5E-01	0.0081
Molybdenum	0.700	ND	ND	1	0.700	1	0.700	1	1	NA	1.1E-02	3.5E+00	0.0031
Nickel	26.6	0.00221	24.4	1	26.6	Regression	3.60	1	390	0.862	2.9E-01	6.7E+00	0.043
Selenium	1.80	0.00100	1.60	Regression	1.43	Regression	0.823	1	645	0.65	4.8E-02	2.9E-01	0.17
Silver	NA	ND	0.241	2.045	NA	NA	NA	1	439	0.24	1.1E-02	2.0E+00	0.0056
Thallium	0.428	0.000150	0.378	1	0.428	0.1124	0.0481	1	50,000	7.50	3.5E-01	3.5E-01	1.0
Uranium	3.76	0.00120	2.37	1	3.76	1	3.76	1	1	0.00120	6.0E-02	1.6E+01	0.0037
Vanadium	57.3	0.00620	45.2	0.042	2.41	0.0123	0.705	1	1	0.00620	4.4E-02	3.4E-01	0.13
Zinc	158	0.0150	151	Regression	450	Regression	112	1.833	10,295	154	1.2E+01	6.6E+01	0.18

Notes:

BAF_{S-I} - bioaccumulation factor from soil to terrestrial invertebrates
BAF_{S-V} - bioaccumulation factor from soil to terrestrial vertebrates (birds and mammals)
BAF_{Sed-F} - bioaccumulation factor from sediment to fish
BAF_{W-F} - bioaccumulation factor from water to fish
C_{RIP_SOIL} - Riparian Soil Concentration
$C_{SEDIMENT}$ - Sediment Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
ND - not detected
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Body Weight:	2.336	kg
Food Ingestion Rate (FIR):	0.145	kg (dry wt)/day
FIR_Terrestrial Inverts (12.5%):	0.0182	kg (dry wt)/day
FIR_Terrestrial Vertebrates (12.5%):	0.0182	kg (dry wt)/day
FIR_Upland Soil (0%):	0	kg (dry wt)/day
FIR_Fish (75%):	0.11	kg (dry wt)/day
FIR_Riparian Soil (0%):	0	kg (dry wt)/day
FIR_Sediment (0.7%):	0.00102	kg (dry wt)/day
Water Ingestion Rate:	0.104	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	11	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier I Background Ecological Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at background locations. Exposure point concentrations are shown for both surface water and sediment for metals that were COPECs in either medium for biota uptake modeling.

[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 through A4-15.

[c] The terrestrial invertebrate (C_{INVERT}), terrestrial vertebrate ($C_{VERTIBRATE}$), and aquatic invertebrate (C_{FISH}) concentrations were calculated from the soil, sediment, or surface water concentration and the soil-, sediment-, or surface water-to-biota bioaccumulation factors.

[d] The aquatic invertebrate EPC is calculated using the sediment to invertebrate BAF for analytes detected in sediment; otherwise the aquatic invertebrate EPC is based on the water to invertebrate BAF. The fish EPC is calculated using the water to fish BAF for analytes detected in surface water; otherwise the fish EPC is based on the sediment to fish BAF.

[e] The ingestion dose for the great blue heron accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16.

Table G-11
Tier I Background Ecological Hazard Calculations for the Northern Harrier

Constituent	EPC [a] C_{UP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	BAF_{S-I} [b]	EPC C_{INVERT} [c] (mg/kg)	BAF_{S-V} [b]	EPC $C_{VERTEBRATES}$ [c] (mg/kg)	Ingestion Dose [d] (mg/kg-day)	TRV NOAEL (mg/kg-day)	Ecological Hazard
Aluminum	NA	0.410	NA	NA	NA	NA	3.2E-02	1.1E+02	0.00029
Antimony	3.60	NA	1	3.60	0.05	0.180	3.0E-02	na	na
Arsenic	19.0	NA	Regression	1.93	Regression	0.0875	2.8E-02	2.2E+00	0.012
Barium	NA	0.0850	NA	NA	NA	NA	6.5E-03	2.1E+01	0.00031
Boron	25.0	0.0200	1	25.0	1	25.0	2.7E+00	2.9E+01	0.095
Cadmium	44.0	0.000100	Regression	168	Regression	1.70	5.8E-01	1.5E+00	0.39
Chromium	420	NA	0.306	129	Regression	19.5	2.7E+00	2.7E+00	1.0
Copper	82.0	NA	0.515	42.2	Regression	14.6	1.7E+00	4.1E+00	0.42
Manganese	NA	0.0484	Regression	NA	NA	NA	3.7E-03	1.8E+02	0.000021
Mercury	0.320	NA	Regression	0.441	0.1920	0.0614	7.7E-03	4.5E-01	0.017
Molybdenum	29.0	NA	1	29.0	1	29.0	3.2E+00	3.5E+00	0.90
Nickel	230	0.00221	1	230	Regression	9.84	1.7E+00	6.7E+00	0.26
Selenium	29.0	0.00100	Regression	10.9	Regression	2.34	2.9E-01	2.9E-01	1.0
Silver	2.40	NA	2.045	4.91	0.0040	0.00960	1.3E-02	2.0E+00	0.0067
Thallium	1.30	NA	1	1.30	0.1124	0.146	1.9E-02	3.5E-01	0.056
Uranium	42.0	0.00120	1	42.0	1	42.0	4.6E+00	1.6E+01	0.29
Vanadium	370	0.00620	0.042	15.5	0.0123	4.55	8.0E-01	3.4E-01	**2.3**
Zinc	1,200	0.0150	Regression	875	Regression	130	1.7E+01	6.6E+01	0.25

Notes:
BAF_{S-I} - bioaccumulation factor from soil to terrestrial invertebrates
BAF_{S-V} - bioaccumulation factor from soil to terrestrial vertebrates
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Parameter	Value	Units
Body Weight:	0.449	kg
Food Ingestion Rate (FIR):	0.049	kg (dry wt)/day
FIR_Terrestrial Inverts (2%):	0.00097	kg (dry wt)/day
FIR_Terrestrial Vertebrates (98%):	0.0477	kg (dry wt)/day
FIR_Upland Soil (0.7%):	0.000341	kg (dry wt)/day
Water Ingestion Rate:	0.034	L/day
Exposure Duration (ED):	1.00	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	642	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier I Background Ecological Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at background locations.
[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 and A4-15.
[c] The terrestrial invertebrate (C_{INVERT}) and terrestrial vertebrate ($C_{VERTIBRATE}$) concentrations were calculated from the soil concentration and the soil-to-biota bioconcentration factors.
[d] The ingestion dose for the northern harrier accounts for exposure to soil based upon terrestrial foraging habits as presented in Appendix A4-13 and A4-15.

ATTACHMENT H – TIER II HENRY SITE ECOLOGICAL HAZARD CALCULATIONS

Table H-1
Tier II Henry Site Ecological Hazard Calculations for the Long-Tailed Vole

	EPC [a]		BAF$_{S\text{-}P}$ [b]	EPC	Measured Plant	Ingestion	TRV		Ecological Hazard	
	C_{UP_SOIL}	C_{WATER}		C_{PLANT} [c]	Concentration [d]	Dose [e]	NOAEL	LOAEL		
Constituent	**(mg/kg)**	**(mg/L)**		**(mg/kg)**	**(mg/kg)**	**(mg/kg-day)**	**(mg/kg-day)**		**High**	**Low**
Aluminum	NA	0.165	NA	NA	NA	2.3E-02	1.9E+00	1.9E+01	0.012	0.0012
Antimony	4.81	NA	Regression	0.172	0.518	2.0E-01	5.9E-02	5.9E-01	**3.3**	0.33
Arsenic	24.9	NA	0.0375	0.934	1.60	6.8E-01	1.0E+00	1.7E+00	0.65	0.41
Cadmium	32.5	0.00371	Regression	4.16	1.71	7.7E-01	7.7E-01	9.1E-01	1.0	0.85
Chromium	271	NA	0.041	11.1	3.26	3.0E+00	2.4E+00	2.8E+00	**1.3**	**1.1**
Copper	124	NA	Regression	13.0	7.08	3.1E+00	5.6E+00	6.8E+00	0.55	0.46
Molybdenum	16.8	NA	0.25	4.21	19.9	6.3E+00	2.6E-01	2.6E+00	**24**	**2.4**
Nickel	212	0.138	Regression	5.95	4.54	3.0E+00	1.7E+00	2.7E+00	**1.8**	**1.1**
Selenium	46.4	0.102	Regression	35.2	16.4	5.4E+00	1.4E-01	1.5E-01	**38**	**37**
Thallium	1.31	NA	0.004	0.00522	0.239	8.3E-02	3.7E-03	3.7E-02	**23**	**2.3**
Uranium	40.5	0.00586	0.0085	0.344	0.141	3.4E-01	3.1E+00	6.1E+00	0.11	0.056
Vanadium	212	0.00989	0.00485	1.03	1.24	2.0E+00	4.2E+00	5.1E+00	0.47	0.38
Zinc	890	0.484	Regression	208	56.0	2.4E+01	7.5E+01	7.6E+01	0.32	0.32

Notes:
BAF$_{S\text{-}P}$ - bioaccumulation factor from soil to plants
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
LOAEL - lowest observed adverse effects level
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
mg/L - milligrams per liter
NA - not applicable
na - not available
ND - not detected
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	0.037	kg
Food Ingestion Rate (FIR):	0.0115	kg (dry wt)/day
FIR_Plants (100%):	0.0115	kg (dry wt)/day
FIR_Soil (2.4%):	0.00028	kg (dry wt)/day
Water Ingestion Rate:	0.0051	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	0.066	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier II Ecological Risk Assessment are equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration measured in samples collected from the Henry Site.
[b] The soil-to-plant bioconcentration factor was derived from sources listed in Table A4-13 and A4-15.
[c] The plant concentration (C_{PLANT}) was calculated from the upland soil concentration and the soil-to-plant bioconcentration factor (BCF$_{S\text{-}P}$).
[d] The measured plant concentration is equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration detected in plant tissue collected from Henry Site.
[e] The ingestion dose for the long-tailed vole accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from upland soil.

Table I-2
Tier II Background Ecological Hazard Calculations for the American Goldfinch

Constituent	EPC [a] C_{UP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	BAF_{S-P} [b]	EPC C_{PLANT} [c] (mg/kg)	Measured Plant Concentration [d] (mg/kg)	Ingestion Dose [e] (mg/kg-day)	TRV NOAEL (mg/kg-day)	TRV LOAEL (mg/kg-day)	Ecological Hazard High	Ecological Hazard Low
Aluminum	NA	0.0990	NA	NA	NA	2.3E-02	1.1E+02	na	0.00021	na
Antimony	1.04	NA	Regression	0.041	5.41	1.5E+00	na	na	na	na
Arsenic	8.20	NA	0.0375	0.308	NA	3.1E-01	2.2E+00	3.6E+00	0.14	0.086
Cadmium	13.6	0.000100	Regression	2.59	0.461	5.0E-01	1.5E+00	2.4E+00	0.34	0.21
Chromium	108	NA	0.041	4.4	NA	4.1E+00	2.7E+00	2.8E+00	**1.6**	**1.5**
Copper	27.0	NA	Regression	7.14	NA	2.6E+00	4.1E+00	4.7E+00	0.65	0.56
Molybdenum	7.94	NA	0.25	1.99	2.09	7.7E-01	3.5E+00	3.5E+01	0.22	0.022
Nickel	69.8	0.00129	Regression	2.59	NA	2.6E+00	6.7E+00	1.2E+01	0.39	0.23
Selenium	6.67	0.000579	Regression	4.13	0.66	3.6E-01	2.9E-01	3.7E-01	**1.2**	0.97
Thallium	0.510	NA	0.004	0.00204	0.0113	1.7E-02	3.5E-01	3.5E+00	0.049	0.0049
Uranium	10.2	0.000529	0.0085	0.0863	0.162	3.2E-01	1.6E+01	na	0.020	na
Vanadium	93.3	0.00140	0.00485	0.452	NA	2.7E+00	3.4E-01	4.1E-01	**7.8**	**6.5**
Zinc	473	0.00525	Regression	146	NA	5.2E+01	6.6E+01	6.7E+01	0.78	0.78

Notes:
BAF_{S-P} - bioaccumulation factor from soil to plants
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
LOAEL - lowest observed adverse effects level
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
mg/L - milligrams per liter
NA - not applicable
na - not available
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters		
Body Weight:	0.0155	kg
Food Ingestion Rate (FIR):	0.0041	kg (dry wt)/day
FIR_Plants (100%):	0.0041	kg (dry wt)/day
FIR_Soil (10.4%):	0.000426	kg (dry wt)/day
Water Ingestion Rate:	0.00362	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	0.119	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier II Background Ecological Risk Assessment are equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration measured in samples collected from Background locations.
[b] The soil-to-plant bioconcentration factor was derived from sources listed in Table A4-13 and A4-15.
[c] The plant concentration (C_{PLANT}) was calculated from the upland soil concentration and the soil-to-plant bioconcentration factor (BCF_{S-P}).
[d] The measured plant concentration is equal to either the recommended 95%, 97.5%, or 99% upper confidence limit on the mean concentration or the maximum detected concentration detected in plant tissue collected from background locations.
[e] The ingestion dose for the American goldfinch accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from upland soil.

Table I-3
Tier II Background Ecological Hazard Calculations for the Deer Mouse

Constituent	EPC [a] C_{UP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	BAF_{S-P} [b]	EPC C_{PLANT} [c] (mg/kg)	Measured Plant Concentration [d] (mg/kg)	BAF_{S-I} [b]	EPC C_{INVERT} [c] (mg/kg)	Ingestion Dose [e] (mg/kg-day)	TRV NOAEL (mg/kg-day)	Ecological Hazard High	Ecological Hazard Low
Aluminum	NA	0.0990	NA	NA	NA	NA	NA	1.5E-02	1.9E+00	0.0075	0.00075
Antimony	1.04	NA	Regression	0.0410	5.41	1	1.04	7.3E-01	5.9E-02	**12**	**1.2**
Arsenic	8.20	NA	0.0375	0.308	NA	Regression	1.07	1.5E-01	1.0E+00	0.14	0.090
Cadmium	13.6	0.000100	Regression	2.59	0.461	Regression	66.1	5.1E+00	7.7E-01	**6.6**	**5.6**
Chromium	108	NA	0.041	4.42	NA	0.306	33.0	3.4E+00	2.4E+00	**1.4**	**1.2**
Copper	27.0	NA	Regression	7.14	NA	0.515	13.9	2.0E+00	5.6E+00	0.36	0.30
Molybdenum	7.94	NA	0.25	1.99	2.09	1	7.94	8.8E-01	2.6E-01	**3.4**	0.34
Nickel	69.8	0.00129	Regression	2.59	NA	1	69.8	5.8E+00	1.7E+00	**3.4**	**2.2**
Selenium	6.67	0.000579	Regression	4.13	0.662	Regression	3.73	3.9E-01	1.4E-01	**2.7**	**2.7**
Thallium	0.510	NA	0.0040	0.00204	0.0113	1	0.510	4.2E-02	3.7E-03	**11**	**1.1**
Uranium	10.2	0.000529	0.0085	0.0863	0.162	1	10.2	8.2E-01	3.1E+00	0.27	0.13
Vanadium	93.3	0.00140	0.00485	0.452	NA	0.042	3.92	7.1E-01	4.2E+00	0.17	0.14
Zinc	473	0.00525	Regression	146	NA	Regression	645	6.8E+01	7.5E+01	0.90	0.90

Notes:
BAF_{S-I} - bioaccumulation factor from soil to invertebrates
BAF_{S-P} - bioaccumulation factor from soil to plants
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
LOAEL - lowest observed adverse effects level
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
na - not available
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	0.0195	kg
Food Ingestion Rate (FIR):	0.0038	kg (dry wt)/day
FIR_Plants (61.5%):	0.0023	kg (dry wt)/day
FIR_Inverts (38.5%):	0.0015	kg (dry wt)/day
FIR_Soil (2%):	0.0001	kg (dry wt)/day
Water Ingestion Rate:	0.0029	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	0.27	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier II Background Ecological Risk Assessment are equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration measured in samples collected from Background locations.
[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 and A4-15.
[c] The plant (C_{PLANT}) and terrestrial invertebrate (C_{INVERT}) concentrations were calculated from upland soil concentration and the soil-to-biota bioconcentration factors (BCF_{S-P} and BCF_{S-I}).
[d] The measured plant concentration is equal to either the recommended 95%, 97.5%, or 99% upper confidence limit on the mean concentration or the maximum detected concentration detected in plant tissue collected from background locations.
[e] The ingestion dose for the deer mouse accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from upland soil.

Table H-4
Tier II Henry Site Ecological Hazard Calculations for the Raccoon

	EPC [a]			BAF_{S-P} [b]	EPC	Measured Plant	BAF_{S-I} [b]	EPC	BAF_{S-V} [b]	EPC	BAF_{Sed-I} [b]	BAF_{W-I} [b]	EPC	BCF_{Sed-F} [b]	BCF_{W-F} [b]	EPC	Ingestion	TRV		Ecological Hazard	
	C_{RIP_SOIL}	C_{WATER}	$C_{SEDIMENT}$		C_{PLANT} [c]	Concentration [d]		C_{INVERT} [c]		$C_{VERTEBRATES}$ [c]			$C_{AQ\ INVERT}$ [c, e]			C_{FISH} [c, e]	Dose [f]	NOAEL	LOAEL		
Constituent	**(mg/kg)**	**(mg/L)**	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**		**(mg/kg)**		**(mg/kg)**			**(mg/kg)**			**(mg/kg)**	**(mg/kg-day)**	**(mg/kg-day)**		**High**	**Low**
Aluminum	NA	0.165	NA	NA	NA	NA	NA	NA	NA	NA	NA	24,355	4,019	1	13.5	2.23	3.4E+00	1.9E+00	1.9E+01	**1.8**	0.18
Antimony	6.17	0.000657	6.03	Regression	0.217	NA	1	6.17	0.05	0.308	1.0	41.9	6.03	1	200	0.131	2.8E-02	5.9E-02	5.9E-01	0.48	0.048
Arsenic	NA	0.00928	7.49	NA	NA	NA	NA	NA	NA	NA	Regression	437.3	2.33	0.012	570	5.29	2.6E-03	1.0E+00	1.7E+00	0.0025	0.0016
Cadmium	7.38	0.00371	27.1	Regression	1.85	0.692	Regression	40.6	Regression	0.731	Regression	20,731	10.7	0.785	4,535	16.8	1.2E-01	7.7E-01	9.1E-01	0.15	0.13
Chromium	123	0.00159	217	0.041	5.06	NA	0.306	37.7	Regression	7.95	Regression	17,970	11.5	0.043	95.00	0.151	2.8E-01	2.4E+00	2.8E+00	0.12	0.10
Copper	22.0	0.00263	41.5	Regression	6.59	4.93	0.515	11.3	Regression	12.0	Regression	22,271	34.6	1	3,550	9.34	1.3E-01	5.6E+00	6.8E+00	0.024	0.019
Molybdenum	4.64	0.0111	4.29	0.25	1.16	3.15	1	4.64	1	4.64	1	1	4.29	1	1	0.0111	4.9E-02	2.6E-01	2.6E+00	0.19	0.019
Nickel	70.4	0.138	199	Regression	2.61	NA	1	70.4	Regression	5.67	Regression	168	3.19	1	390	53.8	2.8E-01	1.7E+00	2.7E+00	0.17	0.10
Selenium	14.9	0.102	49.8	Regression	10.1	8.65	Regression	6.73	Regression	1.83	Regression	7559.4	16.3	1	645	65.8	1.3E-01	1.4E-01	1.5E-01	0.88	0.87
Thallium	0.200	0.0000813	1.12	0.0040	0.000800	NA	1	0.200	0.1124	0.0225	1	89,850	1.12	1	50,000	4.06	2.1E-03	3.7E-03	3.7E-02	0.58	0.058
Uranium	1.43	0.00586	30.6	0.0085	0.0122	NA	1	1.43	1	1.43	1	1	30.6	1	1	0.00586	3.2E-02	3.1E+00	6.1E+00	0.011	0.0053
Vanadium	165	0.00989	231	0.00485	0.800	NA	0.042	6.93	0.012	2.03	0.04	1	9.69	1	1	0.00989	2.2E-01	4.2E+00	5.1E+00	0.053	0.043
Zinc	397	0.484	1,385	Regression	133	95.6	Regression	609	Regression	120	Regression	27,422	284	1.833	10,295	4,983	3.6E+00	7.5E+01	7.6E+01	0.047	0.047

Notes:

BAF_{S-I} - bioaccumulation factor from soil to invertebrates
BAF_{S-P} - bioaccumulation factor from soil to plants
BAF_{S-V} - bioaccumulation factor from soil to terrestrial vertebrates
BAF_{Sed-F} - bioaccumulation factor from sediment to fish
BAF_{Sed-I} - bioaccumulation factor from sediment to aquatic invertebrates
BAF_{W-F} - bioaccumulation factor from water to fish
BAF_{W-I} - bioaccumulation factor from water to aquatic invertebrates
C_{FISH} - Fish Concentration
C_{RIP_SOIL} - Riparian Soil Concentration
$C_{SEDIMENT}$ - Sediment Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
LOAEL - lowest observed adverse effects level
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
na - not available
ND - not detected
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	5.8	kg
Food Ingestion Rate (FIR):	0.154	kg (dry wt)/day
FIR_Terrestrial Plants (64%):	0.0985	kg (dry wt)/day
FIR_Terrestrial Inverts (19%):	0.0292	kg (dry wt)/day
FIR_Terrestrial Vertebrates (9%):	0.0138	kg (dry wt)/day
FIR_Upland Soil (0%):	0	kg (dry wt)/day
FIR_Aquatic Plants (0%):	0	kg (dry wt)/day
FIR_Aquatic Inverts (7%):	0.0108	kg (dry wt)/day
FIR_Fish (1%):	0.0015	kg (dry wt)/day
FIR_Riparian Soil (9.4%):	0.0145	kg (dry wt)/day
Water Ingestion Rate:	0.4816	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	0.453	unitless
Home range:	2,272	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier II Ecological Risk Assessment are equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration measured in samples collected from the Henry Site. Exposure point concentrations are shown for both surface water and sediment for metals that were COPECs in either medium for biota uptake modeling.

[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 through A4-15.

[c] The terrestrial plant (C_{PLANT}), terrestrial invertebrate (C_{INVERT}), terrestrial vertebrate ($C_{VERTIBRATE}$), aquatic invertebrate ($C_{AQ\ INVERT}$), and fish (C_{FISH}) concentrations were calculated from the soil, sediment, or surface water concentration and the soil-, sediment-, or surface water-to-biota bioconcentration factors.

[d] The measured plant concentration is equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration detected in plant tissue collected from Henry Site.

[e] The aquatic invertebrate EPC is calculated using the sediment to invertebrate BAF for analytes detected in sediment; otherwise the aquatic invertebrate EPC is based on the water to invertebrate BAF. The fish EPC is calculated using the water to fish BAF for analytes detected in surface water; otherwise the fish EPC is based on the sediment to fish BAF.

[f] The ingestion dose for the raccoon accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from riparian soil.

Table H-5
Tier II Henry Site Ecological Hazard Calculations for the American Robin

Constituent	EPC [a] C_{UP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	$BAF_{S\text{-}P}$ [b]	EPC C_{PLANT} [c] (mg/kg)	Measured Plant Concentration [d] (mg/kg)	$BAF_{S\text{-}I}$ [b]	EPC C_{INVERT} [c] (mg/kg)	Ingestion Dose [e] (mg/kg-day)	TRV NOAEL (mg/kg-day)	TRV LOAEL (mg/kg-day)	Ecological Hazard High	Ecological Hazard Low
Aluminum	NA	0.165	NA	NA	NA	NA	NA	2.2E-02	1.1E+02	na	0.00020	na
Antimony	4.81	NA	Regression	0.172	0.518	1	4.81	4.4E-01	na	na	na	na
Arsenic	24.9	NA	0.0375	0.934	1.60	Regression	2.34	6.0E-01	2.2E+00	3.6E+00	0.27	0.17
Cadmium	32.5	0.00371	Regression	4.16	1.71	Regression	132	1.0E+01	1.5E+00	2.4E+00	**6.8**	**4.2**
Chromium	271	NA	0.041	11.1	3.26	0.306	83.0	9.8E+00	2.7E+00	2.8E+00	**3.7**	**3.5**
Copper	124	NA	Regression	13.0	7.08	0.515	63.8	6.6E+00	4.1E+00	4.7E+00	**1.6**	**1.4**
Molybdenum	16.8	NA	0.25	4.21	19.9	1	16.8	2.6E+00	3.5E+00	3.5E+01	0.74	0.073
Nickel	212	0.138	Regression	5.95	4.54	1	212	1.8E+01	6.7E+00	1.2E+01	**2.7**	**1.6**
Selenium	46.4	0.102	Regression	35.2	16.4	Regression	15.5	2.7E+00	2.9E-01	3.7E-01	**9.3**	**7.3**
Thallium	1.31	NA	0.0040	0.00522	0.239	1	1.31	1.2E-01	3.5E-01	3.5E+00	0.36	0.036
Uranium	40.5	0.00586	0.0085	0.344	0.141	1	40.5	3.5E+00	1.6E+01	na	0.22	na
Vanadium	212	0.00989	0.00485	1.03	1.24	0.042	8.90	3.6E+00	3.4E-01	4.1E-01	**10**	**8.6**
Zinc	890	0.484	Regression	208	56	Regression	793	7.2E+01	6.6E+01	6.7E+01	**1.1**	**1.1**

Notes:
$BAF_{S\text{-}I}$ - bioaccumulation factor from soil to invertebrates
$BAF_{S\text{-}P}$ - bioaccumulation factor from soil to plants
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
LOAEL - lowest observed adverse effects level
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
na - not available
ND - not detected
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters		
Body Weight:	0.08195	kg
Food Ingestion Rate (FIR):	0.0106	kg (dry wt)/day
FIR_Plants (44.7%):	0.0047	kg (dry wt)/day
FIR_Inverts (55.3%):	0.0059	kg (dry wt)/day
FIR_Soil (10.4%):	0.0011	kg (dry wt)/day
Water Ingestion Rate:	0.0110	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	0.72	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier II Ecological Risk Assessment are equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration measured in samples collected from the Henry Site.

[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 and A4-15.

[c] The plant (C_{PLANT}) and terrestrial invertebrate (C_{INVERT}) concentrations were calculated from upland soil concentration and the soil-to-biota bioconcentration factors ($BCF_{S\text{-}P}$ and $BCF_{S\text{-}I}$).

[d] The measured plant concentration is equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration detected in plant tissue collected from Henry Site.

[e] The ingestion dose for the American robin accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from upland soil.

Table H-6
Tier II Henry Site Ecological Hazard Calculations for the Mallard

	EPC[a]		BAF$_{Sed\text{-}P}$ [b]	BAF$_{W\text{-}P}$ [b]	EPC	BAF$_{Sed\text{-}I}$ [b]	BAF$_{W\text{-}I}$ [b]	EPC	Ingestion	TRV		Ecological Hazard	
	C_{WATER}	$C_{SEDIMENT}$			$C_{AQ\ PLANT}$ [c]			$C_{AQ\ INVERT}$ [c]	Dose [d]	NOAEL	LOAEL		
Constituent	**(mg/L)**	**(mg/kg)**			**(mg/kg)**			**(mg/kg)**	**(mg/kg-day)**	**(mg/kg-day)**		**High**	**Low**
Aluminum	0.165	NA	NA	2,432	401	NA	24,355	4,019	1.4E+02	1.1E+02	na	**1.3**	na
Antimony	0.000657	6.03	Regression	4,307	0.213	1	41.9	6.03	2.2E-01	na	na	na	na
Arsenic	0.00928	7.49	0.0375	856	0.281	Regression	437	2.33	9.5E-02	2.2E+00	3.6E+00	0.042	0.027
Cadmium	0.00371	27.1	Regression	2,283	3.77	Regression	20,731	10.7	4.5E-01	1.5E+00	2.4E+00	0.31	0.19
Chromium	0.00159	217	0.041	12,866	8.91	Regression	17,970	11.5	8.3E-01	2.7E+00	2.8E+00	0.31	0.30
Copper	0.00263	41.5	Regression	1,580	8.47	Regression	22,271	34.6	1.3E+00	4.1E+00	4.7E+00	0.33	0.29
Molybdenum	0.0111	4.29	0.25	1	1.07	1	1	4.29	1.7E-01	3.5E+00	3.5E+01	0.047	0.0047
Nickel	0.138	199	Regression	178	5.67	Regression	168	3.19	4.8E-01	6.7E+00	1.2E+01	0.072	0.042
Selenium	0.102	49.8	Regression	5,387	38.0	Regression	7,559	36.5	1.8E+00	2.9E-01	3.7E-01	**6.1**	**4.8**
Thallium	0.0000813	1.12	0.004	43,800	0.00446	1	89,850	1.12	4.0E-02	3.5E-01	3.5E+00	0.12	0.012
Uranium	0.00586	30.6	0.0085	1	0.260	1	1	30.6	1.1E+00	1.6E+01	na	0.069	na
Vanadium	0.00989	231	0.00485	1	1.12	0.042	1	9.69	7.0E-01	3.4E-01	4.1E-01	**2.0**	**1.7**
Zinc	0.484	1,385	Regression	6,351	266	Regression	27,422	284	1.5E+01	6.6E+01	6.7E+01	0.23	0.23

Notes:
BAF$_{Sed\text{-}I}$ - bioaccumulation factor from sediment to aquatic invertebrates
BAF$_{Sed\text{-}P}$ - bioaccumulation factor from sediment to aquatic plants
BCF$_{W\text{-}I}$ - bioaccumulation factor from water to aquatic invertebrates
BCF$_{W\text{-}P}$ - bioaccumulation factor from water to aquatic plants
$C_{SEDIMENT}$ - Sediment Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
LOAEL - lowest observed adverse effects level
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
ND - not detected
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	1.178	kg
Food Ingestion Rate (FIR):	0.0564	kg (dry wt)/day
FIR_Aquatic Plants (25%):	0.0143	kg (dry wt)/day
FIR_Aquatic Inverts (75%):	0.0422	kg (dry wt)/day
FIR_Sediment (3.3%):	0.00186	kg (dry wt)/day
Water Ingestion Rate:	0.0658	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	0.959	unitless
Home range:	1,074	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier II Ecological Risk Assessment are equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration measured in samples collected from the Henry Site. The measured plant concentration is equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration detected in plant tissue collected from Henry Site. Exposure point concentrations are shown for both surface water and sediment for metals that were COPECs in either medium for biota uptake modeling.

[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-14 and A4-15.

[c] The aquatic plant ($C_{AQ\ PLANT}$) and aquatic invertebrate ($C_{AQ\ INVERT}$) concentrations were calculated from the sediment concentration and the sediment-to-biota bioaccumulation factors.

[d] The ingestion dose for the mallard accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16.

Table H-7
Tier II Henry Site Ecological Hazard Calculations for the Mink

Constituent	EPC [a] C_{RIP_SOIL} (mg/kg)	C_{WATER} (mg/L)	$C_{SEDIMENT}$ (mg/kg)	BAF_{S-V} [b]	EPC $C_{VERTEBRATES}$ [c] (mg/kg)	BAF_{Sed-I} [b]	BAF_{W-I} [b]	EPC $C_{AQ\ INVERT}$ [c,d] (mg/kg)	BCF_{Sed-F} [b]	BCF_{W-F} [b]	EPC C_{FISH} [c,d] (mg/kg)	Ingestion Dose [e] (mg/kg-day)	TRV NOAEL (mg/kg-day)	TRV LOAEL (mg/kg-day)	Ecological Hazard High	Ecological Hazard Low
Aluminum	NA	0.165	NA	NA	NA	NA	24,355	4,019	1	13.5	2.23	1.2E+02	1.9E+00	1.9E+01	**60**	**6.0**
Antimony	6.17	0.000657	6.03	0.05	0.308	1	42	6.03	1	200	0.131	5.6E-01	5.9E-02	5.9E-01	**9.6**	0.96
Arsenic	NA	0.00928	7.49	NA	NA	Regression	437	2.33	0.0120	570	5.29	8.5E-01	1.0E+00	1.7E+00	0.82	0.51
Cadmium	7.38	0.00371	27.1	Regression	0.731	Regression	20,731	10.7	0.785	4,535	16.8	3.4E+00	7.7E-01	9.1E-01	**4.4**	**3.7**
Chromium	123	0.00159	217	Regression	7.95	Regression	17,970	11.5	0.0430	95	0.151	8.3E+00	2.4E+00	2.8E+00	**3.5**	**3.0**
Copper	22.0	0.00263	41.5	Regression	12.0	Regression	22,271	34.6	1	3,550	9.34	7.0E+00	5.6E+00	6.8E+00	**1.3**	1.0
Molybdenum	4.64	0.0111	4.29	1	4.64	1	1	4.29	1	1	0.0111	1.7E+00	2.6E-01	2.6E+00	**6.7**	0.67
Nickel	70.4	0.138	199	Regression	5.67	Regression	168	3.19	1	390	53.8	1.3E+01	1.7E+00	2.7E+00	**7.7**	**4.8**
Selenium	14.9	0.102	49.8	Regression	1.83	Regression	7,559	16.3	1	645	65.8	1.1E+01	1.4E-01	1.5E-01	**80**	**79**
Thallium	0.200	0.0000813	1.12	0.1124	0.0225	1	89,850	1.12	1	50,000	4.06	6.5E-01	3.7E-03	3.7E-02	**176**	**18**
Uranium	1.43	0.00586	30.6	1	1.43	1	1	30.6	1	1	0.00586	1.4E+00	3.1E+00	6.1E+00	0.45	0.22
Vanadium	165	0.00989	231	0.012	2.03	0.042	1	9.69	1	1	0.00989	8.3E+00	4.2E+00	5.1E+00	**2.0**	**1.6**
Zinc	397	0.484	1,385	Regression	120	Regression	27,422	284	1.83	10,295	4,983	8.0E+02	7.5E+01	7.6E+01	**11**	**11**

Notes:

BAF_{S-V} - bioaccumulation factor from soil to terrestrial vertebrates
BAF_{Sed-I} - bioaccumulation factor from sediment to aquatic invertebrates
BAF_{Sed-F} - bioaccumulation factor from sediment to fish
BAF_{W-I} - bioaccumulation factor from water to aquatic invertebrates
BAF_{W-F} - bioaccumulation factor from water to fish
C_{FISH} - Fish Concentration
C_{RIP_SOIL} - Riparian Soil Concentration
$C_{SEDIMENT}$ - Sediment Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
LOAEL - lowest observed adverse effects level
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
ND - not detected
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	1.075	kg
Food Ingestion Rate (FIR):	0.516	kg (dry wt)/day
FIR_Terrestrial Vertebrates (	0.3252	kg (dry wt)/day
FIR_Upland Soil (0%):	0	kg (dry wt)/day
FIR_Aquatic Inverts (6%):	0.0309	kg (dry wt)/day
FIR_Fish (31%):	0.16	kg (dry wt)/day
FIR_Riparian Soil (9.4%):	0.0485	kg (dry wt)/day
Water Ingestion Rate:	0.106	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	50	acres
Exposure area:	1,030	acres

[a] concentration or the maximum detected concentration measured in samples collected from the Henry Site. Exposure point concentrations are shown for both surface water and sediment for metals that were COPECs in either medium for biota uptake modeling.

[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 through A4-15.

[c] The aquatic invertebrate ($C_{AQ\ INVERT}$), fish (C_{FISH}), and terrestrial vertebrate ($C_{VERTIBRATE}$) concentrations were calculated from the soil, sediment, or surface water concentration and the soil-, sediment-, or

[d] The aquatic invertebrate EPC is calculated using the sediment to invertebrate BAF for analytes detected in sediment; otherwise the aquatic invertebrate EPC is based on the water to invertebrate BAF. The fish EPC is calculated using the water to fish BAF for analytes detected in surface water; otherwise the fish EPC is based on the sediment to fish BAF.

[e] The ingestion dose for the mink accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16.

Table H-8
Tier II Henry Site Ecological Hazard Calculations for the Coyote

Constituent	EPC [a] C_{UP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	BAF_{S-P} [b]	EPC C_{PLANT} [c] (mg/kg)	Measured Plant Concentration [d] (mg/kg)	BAF_{S-I} [b]	EPC C_{INVERT} [c] (mg/kg)	BAF_{S-V} [b]	EPC $C_{VERTEBRATE}$ [c] (mg/kg)	Ingestion Dose [e] (mg/kg-day)	TRV NOAEL (mg/kg-day)	TRV LOAEL (mg/kg-day)	Ecological Hazard High	Ecological Hazard Low
Aluminum	NA	0.165	NA	NA	NA	NA	NA	NA	NA	1.8E-03	1.9E+00	1.9E+01	0.00093	0.000093
Antimony	4.81	NA	Regression	0.172	0.518	1	4.81	0.05	0.240	2.1E-02	5.9E-02	5.9E-01	0.36	0.036
Arsenic	24.9	NA	0.0375	0.934	1.60	Regression	2.34	Regression	0.109	3.9E-02	1.0E+00	1.7E+00	0.038	0.024
Cadmium	32.5	0.00371	Regression	4.16	1.71	Regression	132	Regression	1.47	2.2E-01	7.7E-01	9.1E-01	0.29	0.25
Chromium	271	NA	0.041	11.1	3.26	0.306	83.0	Regression	14.2	1.0E+00	2.4E+00	2.8E+00	0.43	0.36
Copper	124	NA	Regression	13.0	7.08	0.515	63.8	Regression	15.5	8.8E-01	5.6E+00	6.8E+00	0.16	0.13
Molybdenum	16.8	NA	0.25	4.21	19.9	1	16.8	1	16.8	7.8E-01	2.6E-01	2.6E+00	**3.0**	0.30
Nickel	212	0.138	Regression	5.95	4.54	1	212	Regression	9.47	8.7E-01	1.7E+00	2.7E+00	0.51	0.32
Selenium	46.4	0.102	Regression	35.2	16.4	Regression	15.5	Regression	2.80	2.1E-01	1.4E-01	1.5E-01	**1.5**	**1.4**
Thallium	1.31	NA	0.0040	0.00522	0.239	1	1.31	0.1124	0.147	9.3E-03	3.7E-03	3.7E-02	**2.5**	0.25
Uranium	40.5	0.00586	0.0085	0.344	0.141	1	40.5	1	40.5	1.8E+00	3.1E+00	6.1E+00	0.60	0.30
Vanadium	212	0.00989	0.00485	1.03	1.24	0.042	8.90	0.012	2.61	3.9E-01	4.2E+00	5.1E+00	0.093	0.076
Zinc	890	0.484	Regression	208	56.0	Regression	793	Regression	127	7.3E+00	7.5E+01	7.6E+01	0.097	0.097

Notes:

BAF_{S-P} - bioaccumulation factor from soil to plants
BAF_{S-I} - bioaccumulation factor from soil to invertebrates
BAF_{S-V} - bioaccumulation factor from soil to terrestrial vertebrates
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
LOAEL - lowest observed adverse effects level
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
na - not available
ND - not detected
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	13.6	kg
Food Ingestion Rate (FIR):	4.2861	kg (dry wt)/day
FIR_Plants (2%):	0.0857	kg (dry wt)/day
FIR_Inverts (2%):	0.0857	kg (dry wt)/day
FIR_Terrestrial Vertebrates (96%):	4.1147	kg (dry wt)/day
FIR_Soil (2.8%):	0.1200	kg (dry wt)/day
Water Ingestion Rate:	1.0371	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	0.1423	unitless
Home range:	7,240	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier II Ecological Risk Assessment are equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration measured in samples collected from the Henry Site. The measured plant concentration is equal to either the ProUCL recommended 95%, 97.5% or 99%

[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 and A4-15.

[c] The plant (C_{PLANT}), terrestrial invertebrate (C_{INVERT}), and terrestrial vertebrate ($C_{VERTEBRATE}$) concentrations were calculated from the soil concentration and the soil-to-biota bioconcentration factors.

[d] The measured plant concentration is equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration detected in plant tissue collected from Henry Site.

[e] The ingestion dose for the coyote accounts for exposure to soil based upon terrestrial foraging habits as presented in Appendix Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from upland soil.

Table H-9
Tier II Henry Site Ecological Hazard Calculations for the Great Blue Heron

	EPC [a]			BAF$_{S\text{-}I}$ [b]	EPC	BAF$_{S\text{-}V}$ [b]	EPC	BCF$_{Sed\text{-}F}$ [b]	BCF$_{W\text{-}F}$ [b]	EPC	Ingestion	TRV		Ecological	
	C_{RIP_SOIL}	C_{WATER}	$C_{SEDIMENT}$		C_{INVERT} [c]		$C_{VERTEBRATES}$ [c]			C_{FISH} [c,d]	Dose [e]	NOAEL	LOAEL	Hazard	
Constituent	**(mg/kg)**	**(mg/L)**	**(mg/kg)**		**(mg/kg)**		**(mg/kg)**			**(mg/kg)**	**(mg/kg-day)**	**(mg/kg-day)**		**High**	**Low**
Aluminum	NA	0.165	NA	NA	NA	NA	NA	1.0	13.5	2.23	1.1E-01	1.1E+02	na	0.0010	na
Antimony	6.17	0.000657	6.03	1	6.17	0.05	0.308	1	200	0.131	5.9E-02	na	na	na	na
Arsenic	NA	0.00928	7.49	Regression	NA	NA	NA	0.012	570	5.29	2.5E-01	2.2E+00	3.6E+00	0.11	0.070
Cadmium	7.4	0.00371	27.08	Regression	40.6	Regression	0.731	0.785	4,535	16.8	1.1E+00	1.5E+00	2.4E+00	0.76	0.47
Chromium	123	0.00159	217	0.306	37.7	Regression	7.95	0.0430	95	0.151	4.6E-01	2.7E+00	2.8E+00	0.17	0.16
Copper	22.0	0.00263	41.53	0.515	11.3	Regression	12.0	1	3,550	9.34	6.4E-01	4.1E+00	4.7E+00	0.16	0.14
Molybdenum	4.64	0.0111	4.289	1	4.64	1	4.64	1	1	0.0111	7.5E-02	3.5E+00	3.5E+01	0.021	0.0021
Nickel	70.4	0.138	199	1	70.4	Regression	5.67	1	390	53.8	3.2E+00	6.7E+00	1.2E+01	0.48	0.28
Selenium	14.9	0.102	49.8	Regression	6.73	Regression	1.83	1	645	65.8	3.2E+00	2.9E-01	3.7E-01	**11**	**8.6**
Thallium	0.200	0.0000813	1.12	1	0.200	0.1124	0.0225	1	50,000	4.06	1.9E-01	3.5E-01	3.5E+00	0.55	0.055
Uranium	1.43	0.00586	30.6	1	1.43	1	1.43	1	1	0.00586	3.6E-02	1.6E+01	na	0.0023	na
Vanadium	165	0.00989	231	0.042	6.93	0.0123	2.03	1	1	0.00989	1.7E-01	3.4E-01	4.1E-01	0.50	0.41
Zinc	397	0.484	1,385	Regression	609	Regression	120	1.833	10,295	4,983	2.4E+02	6.6E+01	6.7E+01	**3.6**	**3.6**

Notes:

BAF$_{S\text{-}I}$ - bioaccumulation factor from soil to terrestrial invertebrates
BAF$_{S\text{-}V}$ - bioaccumulation factor from soil to terrestrial vertebrates (birds and mammals)
BAF$_{Sed\text{-}F}$ - bioaccumulation factor from sediment to fish
BAF$_{W\text{-}F}$ - bioaccumulation factor from water to fish
C_{RIP_SOIL} - Riparian Soil Concentration
$C_{SEDIMENT}$ - Sediment Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
LOAEL - lowest observed adverse effects level
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
ND - not detected
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	2.336	kg
Food Ingestion Rate (FIR):	0.145	kg (dry wt)/day
FIR_Terrestrial Inverts (12.5%):	0.0182	kg (dry wt)/day
FIR_Terrestrial Vertebrates (12.5%):	0.0182	kg (dry wt)/day
FIR_Upland Soil (0%):	0	kg (dry wt)/day
FIR_Fish (75%):	0.11	kg (dry wt)/day
FIR_Riparian Soil (0%):	0	kg (dry wt)/day
FIR_Sediment (0.7%):	0.00102	kg (dry wt)/day
Water Ingestion Rate:	0.104	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	11	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier II Ecological Risk Assessment are equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration measured in samples collected from the Henry Site. Exposure point concentrations are shown for both surface water and sediment for metals that were

[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 through A4-15.

[c] The terrestrial invertebrate (C_{INVERT}), terrestrial vertebrate ($C_{VERTIBRATE}$), and aquatic invertebrate (C_{FISH}) concentrations were calculated from the soil, sediment, or surface water concentration and the soil-, sediment-, or surface water-to-biota bioconcentration factors.

[d] The aquatic invertebrate EPC is calculated using the sediment to invertebrate BAF for analytes detected in sediment; otherwise the aquatic invertebrate EPC is based on the water to invertebrate BAF. The fish EPC is calculated using the water to fish BAF for analytes detected in surface water; otherwise the fish EPC is based on the sediment to fish BAF.

[e] The ingestion dose for the great blue heron accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16.

Table H-10
Tier II Henry Site Ecological Hazard Calculations for the Northern Harrier

Constituent	EPC [a] C_{UP_SOIL} (mg/kg)	C_{WATER} (mg/L)	$BAF_{S\text{-}I}$ [b]	EPC C_{INVERT} [c] (mg/kg)	$BAF_{S\text{-}V}$ [b]	EPC $C_{VERTEBRATES}$ [c] (mg/kg)	Ingestion Dose [d] (mg/kg-day)	TRV (mg/kg-day) NOAEL	LOAEL	Ecological Hazard High	Low
Aluminum	NA	0.165	NA	NA	NA	NA	1.3E-02	1.1E+02	na	0.00012	na
Antimony	4.81	NA	1	4.81	0.05	0.240	4.0E-02	na	na	na	na
Arsenic	24.9	NA	Regression	2.34	Regression	0.109	3.6E-02	2.2E+00	3.6E+00	0.016	0.010
Cadmium	32.5	0.00371	Regression	132	Regression	1.47	4.7E-01	1.5E+00	2.4E+00	0.32	0.20
Chromium	271	NA	0.306	83.0	Regression	14.2	1.9E+00	2.7E+00	2.8E+00	0.7	0.68
Copper	124	NA	0.515	63.8	Regression	15.5	1.9E+00	4.1E+00	4.7E+00	0.46	0.40
Molybdenum	16.8	NA	1	16.8	1	16.8	1.8E+00	3.5E+00	3.5E+01	0.5	0.052
Nickel	212	0.138	1	212	Regression	9.47	1.6E+00	6.7E+00	1.2E+01	0.24	0.14
Selenium	46.4	0.102	Regression	15.5	Regression	2.80	3.7E-01	2.9E-01	3.7E-01	**1.3**	1.0
Thallium	1.31	NA	1	1.31	0.1124	0.147	1.9E-02	3.5E-01	3.5E+00	0.056	0.0056
Uranium	40.5	0.00586	1	40.5	1	40.5	4.4E+00	1.6E+01	na	0.28	na
Vanadium	212	0.00989	0.042	8.90	0.0123	2.61	4.6E-01	3.4E-01	4.1E-01	**1.3**	**1.1**
Zinc	890	0.484	Regression	793	Regression	127	1.6E+01	6.6E+01	6.7E+01	0.24	0.24

Notes:

$BAF_{S\text{-}I}$ - bioaccumulation factor from soil to terrestrial invertebrates
$BAF_{S\text{-}V}$ - bioaccumulation factor from soil to terrestrial vertebrates
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
LOAEL - lowest observed adverse effects level
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	0.449	kg
Food Ingestion Rate (FIR):	0.049	kg (dry wt)/day
FIR_Terrestrial Inverts (2%):	0.0010	kg (dry wt)/day
FIR_Terrestrial Vertebrates (98%)	0.0477	kg (dry wt)/day
FIR_Upland Soil (0.7%):	0.00034	kg (dry wt)/day
Water Ingestion Rate:	0.034	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	642	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier II Ecological Risk Assessment are equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration measured in samples collected from the Henry Site.
[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 and A4-15.
[c] The terrestrial invertebrate (C_{INVERT}) and terrestrial vertebrate ($C_{VERTIBRATE}$) concentrations were calculated from the soil concentration and the soil-to-biota
[d] The ingestion dose for the northern harrier accounts for exposure to soil based upon terrestrial foraging habits as presented in Appendix A4-13 and A4-15.

ATTACHMENT I – TIER II BACKGROUND ECOLOGICAL HAZARD CALCULATIONS

Table I-1
Tier II Background Ecological Hazard Calculations for the Long-Tailed Vole

Constituent	EPC [a] C_{UP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	BAF_{S-P} [b]	EPC C_{PLANT} [c] (mg/kg)	Measured Plant Concentration [d] (mg/kg)	Ingestion Dose [e] (mg/kg-day)	TRV NOAEL (mg/kg-day)	TRV LOAEL (mg/kg-day)	Ecological Hazard High	Ecological Hazard Low
Aluminum	NA	0.0990	NA	NA	NA	1.4E-02	1.9E+00	1.9E+01	0.0071	0.00071
Antimony	1.04	NA	Regression	0.041	5.41	1.7E+00	5.9E-02	5.9E-01	**28**	**2.8**
Arsenic	8.20	NA	0.0375	0.308	NA	1.6E-01	1.0E+00	1.7E+00	0.15	0.094
Cadmium	13.6	0.000100	Regression	2.59	0.461	2.4E-01	7.7E-01	9.1E-01	0.32	0.27
Chromium	108	NA	0.041	4.42	NA	2.2E+00	2.4E+00	2.8E+00	0.90	0.77
Copper	27.0	NA	Regression	7.14	NA	2.4E+00	5.6E+00	6.8E+00	0.43	0.35
Molybdenum	7.94	NA	0.25	1.99	2.09	7.0E-01	2.6E-01	2.6E+00	**2.7**	0.27
Nickel	69.8	0.00129	Regression	2.59	NA	1.3E+00	1.7E+00	2.7E+00	0.78	0.49
Selenium	6.67	0.000579	Regression	4.13	0.662	2.5E-01	1.4E-01	1.5E-01	**1.8**	**1.8**
Thallium	0.510	NA	0.004	0.00204	0.0113	7.3E-03	3.7E-03	3.7E-02	**2.0**	0.20
Uranium	10.2	0.000529	0.0085	0.0863	0.162	1.3E-01	3.1E+00	6.1E+00	0.041	0.020
Vanadium	93.3	0.00140	0.00485	0.452	NA	8.3E-01	4.2E+00	5.1E+00	0.20	0.16
Zinc	473	0.00525	Regression	146	NA	4.9E+01	7.5E+01	7.6E+01	0.65	0.64

Notes:
BAF_{S-P} - bioaccumulation factor from soil to plants
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
LOAEL - lowest observed adverse effects level
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
mg/L - milligrams per liter
NA - not applicable
na - not available
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Parameter	Value	Units
Body Weight:	0.037	kg
Food Ingestion Rate (FIR):	0.0115	kg (dry wt)/day
FIR_Plants (100%):	0.0115	kg (dry wt)/day
FIR_Soil (2.4%):	0.00028	kg (dry wt)/day
Water Ingestion Rate:	0.0051	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	0.066	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier II Background Ecological Risk Assessment are equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration measured in samples collected from Background locations.
[b] The soil-to-plant bioconcentration factor was derived from sources listed in Table A4-13 and A4-15.
[c] The plant concentration (C_{PLANT}) was calculated from the upland soil concentration and the soil-to-plant bioconcentration factor (BCF_{S-P}).
[d] The measured plant concentration is equal to either the recommended 95%, 97.5%, or 99% upper confidence limit on the mean concentration or the maximum detected concentration detected in plant tissue collected from background locations.
[e] The ingestion dose for the long-tailed vole accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from upland soil.

Table I-2
Tier II Background Ecological Hazard Calculations for the American Goldfinch

Constituent	EPC [a] C_{UP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	BAF_{S-P} [b]	EPC C_{PLANT} [c] (mg/kg)	Measured Plant Concentration [d] (mg/kg)	Ingestion Dose [e] (mg/kg-day)	TRV NOAEL (mg/kg-day)	TRV LOAEL (mg/kg-day)	Ecological Hazard High	Ecological Hazard Low
Aluminum	NA	0.0990	NA	NA	NA	2.3E-02	1.1E+02	na	0.00021	na
Antimony	1.04	NA	Regression	0.041	5.41	1.5E+00	na	na	na	na
Arsenic	8.20	NA	0.0375	0.308	NA	3.1E-01	2.2E+00	3.6E+00	0.14	0.086
Cadmium	13.6	0.000100	Regression	2.59	0.461	5.0E-01	1.5E+00	2.4E+00	0.34	0.21
Chromium	108	NA	0.041	4.4	NA	4.1E+00	2.7E+00	2.8E+00	**1.6**	**1.5**
Copper	27.0	NA	Regression	7.14	NA	2.6E+00	4.1E+00	4.7E+00	0.65	0.56
Molybdenum	7.94	NA	0.25	1.99	2.09	7.7E-01	3.5E+00	3.5E+01	0.22	0.022
Nickel	69.8	0.00129	Regression	2.59	NA	2.6E+00	6.7E+00	1.2E+01	0.39	0.23
Selenium	6.67	0.000579	Regression	4.13	0.66	3.6E-01	2.9E-01	3.7E-01	**1.2**	0.97
Thallium	0.510	NA	0.004	0.00204	0.0113	1.7E-02	3.5E-01	3.5E+00	0.049	0.0049
Uranium	10.2	0.000529	0.0085	0.0863	0.162	3.2E-01	1.6E+01	na	0.020	na
Vanadium	93.3	0.00140	0.00485	0.452	NA	2.7E+00	3.4E-01	4.1E-01	**7.8**	**6.5**
Zinc	473	0.00525	Regression	146	NA	5.2E+01	6.6E+01	6.7E+01	0.78	0.78

Notes:
BAF_{S-P} - bioaccumulation factor from soil to plants
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
LOAEL - lowest observed adverse effects level
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
mg/L - milligrams per liter
NA - not applicable
na - not available
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	0.0155	kg
Food Ingestion Rate (FIR):	0.0041	kg (dry wt)/day
FIR_Plants (100%):	0.0041	kg (dry wt)/day
FIR_Soil (10.4%):	0.000426	kg (dry wt)/day
Water Ingestion Rate:	0.00362	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	0.119	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier II Background Ecological Risk Assessment are equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the lower of the maximum detected concentration measured in samples collected from Background locations.
[b] The soil-to-plant bioconcentration factor was derived from sources listed in Table A4-13 and A4-15.
[c] The plant concentration (C_{PLANT}) was calculated from the upland soil concentration and the soil-to-plant bioconcentration factor (BCF_{S-P}).
[d] The measured plant concentration is equal to either the recommended 95%, 97.5%, or 99% upper confidence limit on the mean concentration or the lower of the maximum detected concentration detected in plant tissue collected from background locations.
[e] The ingestion dose for the American goldfinch accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from upland soil.

Table I-3
Tier II Background Ecological Hazard Calculations for the Deer Mouse

Constituent	EPC [a] C_{UP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	BAF_{S-P} [b]	EPC C_{PLANT} [c] (mg/kg)	Measured Plant Concentration [d] (mg/kg)	BAF_{S-I} [b]	EPC C_{INVERT} [c] (mg/kg)	Ingestion Dose [e] (mg/kg-day)	TRV NOAEL (mg/kg-day)	Ecological Hazard High	Ecological Hazard Low
Aluminum	NA	0.0990	NA	NA	NA	NA	NA	1.5E-02	1.9E+00	0.0075	0.00075
Antimony	1.04	NA	Regression	0.0410	5.41	1	1.04	7.3E-01	5.9E-02	**12**	**1.2**
Arsenic	8.20	NA	0.0375	0.308	NA	Regression	1.07	1.5E-01	1.0E+00	0.14	0.090
Cadmium	13.6	0.000100	Regression	2.59	0.461	Regression	66.1	5.1E+00	7.7E-01	**6.6**	**5.6**
Chromium	108	NA	0.041	4.42	NA	0.306	33.0	3.4E+00	2.4E+00	**1.4**	**1.2**
Copper	27.0	NA	Regression	7.14	NA	0.515	13.9	2.0E+00	5.6E+00	0.36	0.30
Molybdenum	7.94	NA	0.25	1.99	2.09	1	7.94	8.8E-01	2.6E-01	**3.4**	0.34
Nickel	69.8	0.00129	Regression	2.59	NA	1	69.8	5.8E+00	1.7E+00	**3.4**	**2.2**
Selenium	6.67	0.000579	Regression	4.13	0.662	Regression	3.73	3.9E-01	1.4E-01	**2.7**	**2.7**
Thallium	0.510	NA	0.0040	0.00204	0.0113	1	0.510	4.2E-02	3.7E-03	**11**	**1.1**
Uranium	10.2	0.000529	0.0085	0.0863	0.162	1	10.2	8.2E-01	3.1E+00	0.27	0.13
Vanadium	93.3	0.00140	0.00485	0.452	NA	0.042	3.92	7.1E-01	4.2E+00	0.17	0.14
Zinc	473	0.00525	Regression	146	NA	Regression	645	6.8E+01	7.5E+01	0.90	0.90

Notes:
BAF_{S-I} - bioaccumulation factor from soil to invertebrates
BAF_{S-P} - bioaccumulation factor from soil to plants
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
LOAEL - lowest observed adverse effects level
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
na - not available
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	0.0195	kg
Food Ingestion Rate (FIR):	0.0038	kg (dry wt)/day
FIR_Plants (61.5%):	0.0023	kg (dry wt)/day
FIR_Inverts (38.5%):	0.0015	kg (dry wt)/day
FIR_Soil (2%):	0.0001	kg (dry wt)/day
Water Ingestion Rate:	0.0029	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	0.27	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier II Background Ecological Risk Assessment are equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration measured in samples collected from Background locations.

[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 and A4-15.

[c] The plant (C_{PLANT}) and terrestrial invertebrate (C_{INVERT}) concentrations were calculated from upland soil concentration and the soil-to-biota bioconcentration factors (BCF_{S-P} and BCF_{S-I}).

[d] The measured plant concentration is equal to either the recommended 95%, 97.5%, or 99% upper confidence limit on the mean concentration or the maximum detected concentration detected in plant tissue collected from background locations.

[e] The ingestion dose for the deer mouse accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from upland soil.

Table I-4
Tier II Background Ecological Hazard Calculations for the Raccoon

Constituent	EPC [a] C_{RIP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	EPC [a] $C_{SEDIMENT}$ (mg/kg)	BAF_{S-P} [b]	EPC C_{PLANT} [c] (mg/kg)	Measured Plant Concentration [d] (mg/kg)	BAF_{S-I} [b]	EPC C_{INVERT} [c] (mg/kg)	BAF_{S-V} [b]	EPC $C_{VERTEBRATES}$ [c] (mg/kg)	BAF_{Sed-I} [b]	BAF_{W-I} [b]	EPC $C_{AQ\ INVERT}$ [c, e] (mg/kg)	BCF_{Sed-F} [b]	BCF_{W-F} [b]	EPC C_{FISH} [c, e] (mg/kg)	Ingestion Dose [f] (mg/kg-day)	TRV NOAEL (mg/kg-day)	TRV LOAEL (mg/kg-day)	Ecological Hazard High	Ecological Hazard Low
Aluminum	NA	0.0990	NA	NA	NA	NA	NA	NA	NA	NA	NA	24,355	2,411	1	13.5	1.34	2.0E+00	1.9E+00	1.9E+01	**1.1**	0.11
Antimony	5.50	NA	5.00	Regression	0.195	NA	1	5.50	0.05	0.275	1.0	NA	5.00	1	200	5.00	2.5E-02	5.9E-02	5.9E-01	0.43	0.043
Arsenic	NA	0.000735	4.55	NA	NA	NA	NA	NA	NA	NA	Regression	437.3	1.60	0.012	570	0.419	1.4E-03	1.0E+00	1.7E+00	0.0013	0.00084
Cadmium	2.81	0.000100	2.29	Regression	1.09	0.552	Regression	18.8	Regression	0.463	Regression	20,731	1.95	0.785	4,535	0.454	5.3E-02	7.7E-01	9.1E-01	0.068	0.058
Chromium	27.9	0.000775	26.3	0.041	1.14	NA	0.306	8.53	Regression	2.67	Regression	17,970	5.34	0.043	95.00	0.0736	6.7E-02	2.4E+00	2.8E+00	0.028	0.024
Copper	18.5	NA	25.5	Regression	6.16	NA	0.515	9.54	Regression	11.7	Regression	NA	30.2	1	3,550	25.5	1.3E-01	5.6E+00	6.8E+00	0.023	0.019
Molybdenum	0.508	NA	NA	0.25	0.13	1.76	1	0.51	1	0.508	NA	NA	NA	1	1	NA	1.6E-02	2.6E-01	2.6E+00	0.061	0.0061
Nickel	20.2	0.00129	19.7	Regression	1.03	NA	1	20.2	Regression	3.17	Regression	168	8.51	1	390	0.503	8.8E-02	1.7E+00	2.7E+00	0.052	0.032
Selenium	1.12	0.00058	1.01	Regression	0.575	0.800	Regression	1.01	Regression	0.688	Regression	7559.4	0.935	1	645	0.37	1.1E-02	1.4E-01	1.5E-01	0.079	0.078
Thallium	0.333	0.000150	0.378	0.0040	0.00133	NA	1	0.333	0.1124	0.0374	1	89,850	0.378	1	50,000	7.50	2.4E-03	3.7E-03	3.7E-02	0.65	0.065
Uranium	2.91	0.000529	2.37	0.0085	0.0247	NA	1	2.91	1	2.91	1	1	2.37	1	1	0.000529	1.5E-02	3.1E+00	6.1E+00	0.0050	0.0025
Vanadium	37.0	0.00140	33.0	0.00485	0.179	NA	0.042	1.55	0.012	0.455	0.04	1	1.39	1	1	0.00140	4.8E-02	4.2E+00	5.1E+00	0.012	0.0095
Zinc	117	0.00525	107	Regression	67.5	NA	Regression	408	Regression	110	Regression	27,422	167	1.833	10,295	54.0	1.8E+00	7.5E+01	7.6E+01	0.025	0.024

Notes:

BAF_{S-I} - bioaccumulation factor from soil to invertebrates
BAF_{S-P} - bioaccumulation factor from soil to plants
BAF_{S-V} - bioaccumulation factor from soil to terrestrial vertebrates
BAF_{Sed-F} - bioaccumulation factor from sediment to fish
BAF_{Sed-I} - bioaccumulation factor from sediment to aquatic invertebrates
BAF_{W-F} - bioaccumulation factor from water to fish
BAF_{W-I} - bioaccumulation factor from water to aquatic invertebrates
C_{FISH} - Fish Concentration
C_{RIP_SOIL} - Riparian Soil Concentration
$C_{SEDIMENT}$ - Sediment Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
LOAEL - lowest observed adverse effects level
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
na - not available
ND - not detected
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	5.8	kg
Food Ingestion Rate (FIR):	0.154	kg (dry wt)/day
FIR_Terrestrial Plants (64%):	0.0985	kg (dry wt)/day
FIR_Terrestrial Inverts (19%):	0.0292	kg (dry wt)/day
FIR_Terrestrial Vertebrates (9%):	0.0138	kg (dry wt)/day
FIR_Upland Soil (0%):	0	kg (dry wt)/day
FIR_Aquatic Plants (0%):	0	kg (dry wt)/day
FIR_Aquatic Inverts (7%):	0.0108	kg (dry wt)/day
FIR_Fish (1%):	0.0015	kg (dry wt)/day
FIR_Riparian Soil (9.4%):	0.0145	kg (dry wt)/day
Water Ingestion Rate:	0.4816	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	0.453	unitless
Home range:	2,272	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier II Background Ecological Risk Assessment are equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration measured in samples collected from Background locations. Exposure point concentrations are shown for both surface water and sediment for metals that were COPECs in either medium for biota uptake modeling.

[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 through A4-15.

[c] The terrestrial plant (C_{PLANT}), terrestrial invertebrate (C_{INVERT}), terrestrial vertebrate ($C_{VERTIBRATE}$), aquatic invertebrate ($C_{AQ\ INVERT}$), and fish (C_{FISH}) concentrations were calculated from the soil, sediment, or surface water concentration and the soil-, sediment-, or surface water-to-biota bioconcentration factors.

[d] The measured plant concentration is equal to either the recommended 95%, 97.5%, or 99% upper confidence limit on the mean concentration or the maximum detected concentration detected in plant tissue collected from background locations.

[e] The aquatic invertebrate EPC is calculated using the sediment to invertebrate BAF for analytes detected in sediment; otherwise the aquatic invertebrate EPC is based on the water to invertebrate BAF. The fish EPC is calculated using the water to fish BAF for analytes detected in surface water; otherwise the fish EPC is based on the sediment to fish BAF.

[f] The ingestion dose for the raccoon accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from riparian soil.

Table I-5
Tier II Background Ecological Hazard Calculations for the American Robin

	EPC [a]		BAF_{S-P} [b]	EPC	Measured Plant	BAF_{S-I} [b]	EPC	Ingestion	TRV		Ecological Hazard	
	C_{UP_SOIL}	C_{WATER}		C_{PLANT} [c]	Concentration [d]		C_{INVERT} [c]	Dose [e]	NOAEL	LOAEL		
Constituent	**(mg/kg)**	**(mg/L)**		**(mg/kg)**	**(mg/kg)**		**(mg/kg)**	**(mg/kg-day)**	**(mg/kg-day)**		**High**	**Low**
Aluminum	NA	0.0990	NA	NA	NA	NA	NA	1.3E-02	1.1E+02	na	0.00012	na
Antimony	1.04	NA	Regression	0.0410	5.41	1	1.04	4.0E-01	na	na	na	na
Arsenic	8.20	NA	0.0375	0.308	NA	Regression	1.07	2.0E-01	2.2E+00	3.6E+00	0.091	0.058
Cadmium	13.6	0.000100	Regression	2.59	0.461	Regression	66.1	4.9E+00	1.5E+00	2.4E+00	**3.4**	**2.1**
Chromium	108	NA	0.041	4.42	NA	0.306	33.0	4.1E+00	2.7E+00	2.8E+00	**1.5**	**1.5**
Copper	27.0	NA	Regression	7.14	NA	0.515	13.9	1.8E+00	4.1E+00	4.7E+00	0.44	0.38
Molybdenum	7.94	NA	0.25	1.99	2.09	1	7.94	8.0E-01	3.5E+00	3.5E+01	0.23	0.023
Nickel	69.8	0.00129	Regression	2.59	NA	1	69.8	6.1E+00	6.7E+00	1.2E+01	0.91	0.53
Selenium	6.67	0.000579	Regression	4.13	0.662	Regression	3.73	4.0E-01	2.9E-01	3.7E-01	**1.4**	**1.1**
Thallium	0.510	NA	0.0040	0.00204	0.0113	1	0.510	4.4E-02	3.5E-01	3.5E+00	0.13	0.013
Uranium	10.2	0.000529	0.0085	0.0863	0.162	1	10.2	8.7E-01	1.6E+01	na	0.05	na
Vanadium	93.3	0.00140	0.00485	0.452	NA	0.042	3.92	1.6E+00	3.4E-01	4.1E-01	**4.5**	**3.8**
Zinc	473	0.00525	Regression	146	NA	Regression	645	6.1E+01	6.6E+01	6.7E+01	0.92	0.92

Notes:

BAF_{S-I} - bioaccumulation factor from soil to invertebrates
BAF_{S-P} - bioaccumulation factor from soil to plants
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
LOAEL - lowest observed adverse effects level
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
na - not available
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	0.08195	kg
Food Ingestion Rate (FIR):	0.0106	kg (dry wt)/day
FIR_Plants (44.7%):	0.0047	kg (dry wt)/day
FIR_Inverts (55.3%):	0.0059	kg (dry wt)/day
FIR_Soil (10.4%):	0.0011	kg (dry wt)/day
Water Ingestion Rate:	0.0110	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	0.72	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier II Background Ecological Risk Assessment are equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration measured in samples collected from Background locations.

[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 and A4-15.

[c] The plant (C_{PLANT}) and terrestrial invertebrate (C_{INVERT}) concentrations were calculated from upland soil concentration and the soil-to-biota bioconcentration factors (BCF_{S-P} and BCF_{S-I}).

[d] The measured plant concentration is equal to either the recommended 95%, 97.5%, or 99% upper confidence limit on the mean concentration or the maximum detected concentration detected in plant tissue collected from background locations.

[e] The ingestion dose for the American robin accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from upland soil.

Table I-6
Tier II Background Ecological Hazard Calculations for the Mallard

	EPC[a]				EPC			EPC	Ingestion	TRV		Ecological Hazard	
	C_{WATER}	$C_{SEDIMENT}$	BAF_{Sed-P} [b]	BAF_{W-P} [b]	$C_{AQ\ PLANT}$ [c]	BAF_{Sed-I} [b]	BAF_{W-I} [b]	$C_{AQ\ INVERT}$ [c]	Dose [d]	NOAEL	LOAEL		
Constituent	**(mg/L)**	**(mg/kg)**			**(mg/kg)**			**(mg/kg)**	**(mg/kg-day)**	**(mg/kg-day)**		**High**	**Low**
Aluminum	0.0990	NA	NA	2,432	241	NA	24,355	2,411	8.6E+01	1.1E+02	na	0.78	na
Antimony	NA	5.00	Regression	4,307	0.178	1	41.9	5.00	1.8E-01	na	na	na	na
Arsenic	0.000735	4.55	0.0375	856	0.171	Regression	437	1.60	6.4E-02	2.2E+00	3.6E+00	0.028	0.018
Cadmium	0.000100	2.29	Regression	2,283	0.979	Regression	20,731	1.95	8.2E-02	1.5E+00	2.4E+00	0.056	0.034
Chromium	0.000775	26.3	0.041	12,866	1.08	Regression	17,970	5.34	2.4E-01	2.7E+00	2.8E+00	0.089	0.085
Copper	NA	25.5	Regression	1,580	6.99	Regression	22,271	30.2	1.2E+00	4.1E+00	4.7E+00	0.29	0.25
Nickel	0.00129	19.7	Regression	178	1.01	Regression	168	8.51	3.3E-01	6.7E+00	1.2E+01	0.050	0.029
Selenium	0.000579	1.01	Regression	5,387	0.514	Regression	7,559	2.10	8.0E-02	2.9E-01	3.7E-01	0.27	0.22
Thallium	0.000150	0.378	0.004	43,800	0.00151	1	89,850	0.378	1.4E-02	3.5E-01	3.5E+00	0.039	0.0039
Uranium	0.000529	2.37	0.0085	1	0.0201	1	1	2.37	8.5E-02	1.6E+01	na	0.0053	na
Vanadium	0.00140	33.0	0.00485	1	0.160	0.042	1	1.39	1.0E-01	3.4E-01	4.1E-01	0.29	0.24
Zinc	0.00525	107	Regression	6,351	64.3	Regression	27,422	167	6.6E+00	6.6E+01	6.7E+01	0.10	0.10

Notes:
BAF_{Sed-I} - bioaccumulation factor from sediment to aquatic invertebrates
BAF_{Sed-P} - bioaccumulation factor from sediment to aquatic plants
BCF_{W-I} - bioaccumulation factor from water to aquatic invertebrates
BCF_{W-P} - bioaccumulation factor from water to aquatic plants
$C_{SEDIMENT}$ - Sediment Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
LOAEL - lowest observed adverse effects level
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
ND - not detected
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	1.178	kg
Food Ingestion Rate (FIR):	0.0564	kg (dry wt)/day
FIR_Aquatic Plants (25%):	0.0143	kg (dry wt)/day
FIR_Aquatic Inverts (75%):	0.0422	kg (dry wt)/day
FIR_Sediment (3.3%):	0.00186	kg (dry wt)/day
Water Ingestion Rate:	0.0658	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	0.959	unitless
Home range:	1,074	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier II Background Ecological Risk Assessment are equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration measured in samples collected from Background locations. The measured plant concentration is equal to either the recommended 95%, 97.5%, or 99% upper confidence limit on the mean concentration or the maximum detected concentration detected in plant tissue collected from background locations. Exposure point concentrations are shown for both surface water and sediment for metals that were COPECs in either medium for biota uptake modeling.

[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-14 and A4-15.

[c] The aquatic plant ($C_{AQ\ PLANT}$) and aquatic invertebrate ($C_{AQ\ INVERT}$) concentrations were calculated from the sediment concentration and the sediment-to-biota bioaccumulation factors.

[d] The ingestion dose for the mallard accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16.

Table I-7
Tier II Background Ecological Hazard Calculations for the Mink

Constituent	EPC [a] C_{RIP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	EPC [a] $C_{SEDIMENT}$ (mg/kg)	$BAF_{S\text{-}V}$ [b]	EPC $C_{VERTEBRATES}$ [c] (mg/kg)	$BAF_{Sed\text{-}I}$ [b]	$BAF_{W\text{-}I}$ [b]	EPC $C_{AQ\ INVERT}$ [c,d] (mg/kg)	$BCF_{Sed\text{-}F}$ [b]	$BCF_{W\text{-}F}$ [b]	EPC C_{FISH} [c,d] (mg/kg)	Ingestion Dose [e] (mg/kg-day)	TRV NOAEL (mg/kg-day)	TRV LOAEL (mg/kg-day)	Ecological Hazard High	Ecological Hazard Low
Aluminum	NA	0.0990	NA	NA	NA	NA	24,355	2,411	1	13.5	1.34	6.9E+01	1.9E+00	1.9E+01	**36**	**3.6**
Antimony	5.50	NA	5.00	0.05	0.275	1	NA	5.00	1	200	5.00	1.2E+00	5.9E-02	5.9E-01	**21**	**2.1**
Arsenic	NA	0.000735	4.55	NA	NA	Regression	437	1.60	0.0120	570	0.419	1.1E-01	1.0E+00	1.7E+00	0.10	0.065
Cadmium	2.81	0.000100	2.29	Regression	0.463	Regression	20,731	1.95	0.785	4,535	0.454	3.9E-01	7.7E-01	9.1E-01	0.51	0.43
Chromium	27.9	0.000775	26.3	Regression	2.67	Regression	17,970	5.34	0.0430	95	0.0736	2.2E+00	2.4E+00	2.8E+00	0.93	0.79
Copper	18.5	NA	25.5	Regression	11.7	Regression	NA	30.2	1	3,550	25.5	9.1E+00	5.6E+00	6.8E+00	**1.6**	**1.3**
Molybdenum	0.508	NA	NA	1	0.508	1	NA	NA	1	1	NA	1.8E-01	2.6E-01	2.6E+00	0.68	0.068
Nickel	20.2	0.00129	19.7	Regression	3.17	Regression	168	8.51	1	390	0.503	2.2E+00	1.7E+00	2.7E+00	**1.3**	0.81
Selenium	1.12	0.000579	1.01	Regression	0.688	Regression	7,559	0.935	1	645	0.37	3.4E-01	1.4E-01	1.5E-01	**2.4**	**2.4**
Thallium	0.333	0.000150	0.378	0.1124	0.0374	1	89,850	0.378	1	50,000	7.50	1.2E+00	3.7E-03	3.7E-02	**312**	**31**
Uranium	2.91	0.000529	2.37	1	2.91	1	1	2.37	1	1	0.000529	1.1E+00	3.1E+00	6.1E+00	0.35	0.18
Vanadium	37.0	0.00140	33.0	0.012	0.455	0.042	1	1.39	1	1	0.00140	1.8E+00	4.2E+00	5.1E+00	0.44	0.36
Zinc	117	0.00525	107	Regression	110	Regression	27,422	167	1.83	10,295	54.0	5.1E+01	7.5E+01	7.6E+01	0.68	0.68

Notes:

$BAF_{S\text{-}V}$ - bioaccumulation factor from soil to terrestrial vertebrates
$BAF_{Sed\text{-}I}$ - bioaccumulation factor from sediment to aquatic invertebrates
$BAF_{Sed\text{-}F}$ - bioaccumulation factor from sediment to fish
$BAF_{W\text{-}I}$ - bioaccumulation factor from water to aquatic invertebrates
$BAF_{W\text{-}F}$ - bioaccumulation factor from water to fish
C_{FISH} - Fish Concentration
C_{RIP_SOIL} - Riparian Soil Concentration
$C_{SEDIMENT}$ - Sediment Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
LOAEL - lowest observed adverse effects level
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
ND - not detected
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	1.075	kg
Food Ingestion Rate (FIR):	0.516	kg (dry wt)/day
FIR_Terrestrial Vertebrates	0.3252	kg (dry wt)/day
FIR_Upland Soil (0%):	0	kg (dry wt)/day
FIR_Aquatic Inverts (6%):	0.0309	kg (dry wt)/day
FIR_Fish (31%):	0.16	kg (dry wt)/day
FIR_Riparian Soil (9.4%):	0.0485	kg (dry wt)/day
Water Ingestion Rate:	0.106	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	50	acres
Exposure area:	1,030	acres

[a] concentration or the maximum detected concentration measured in samples collected from Background locations. Exposure point concentrations are shown for both surface water and sediment for metals that were COPECs in either medium for biota uptake modeling.
[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 through A4-15.
[c] The aquatic invertebrate ($C_{AQ\ INVERT}$), fish (C_{FISH}), and terrestrial vertebrate ($C_{VERTIBRATE}$) concentrations were calculated from the soil, sediment, or surface water concentration and the soil-, sediment-, or surface water-
[d] The aquatic invertebrate EPC is calculated using the sediment to invertebrate BAF for analytes detected in sediment; otherwise the aquatic invertebrate EPC is based on the water to invertebrate BAF. The fish EPC is calculated using the water to fish BAF for analytes detected in surface water; otherwise the fish EPC is based on the sediment to fish BAF.
[e] The ingestion dose for the mink accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16.

Table I-8
Tier II Background Ecological Hazard Calculations for the Coyote

Constituent	EPC [a] C_{UP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	BAF_{S-P} [b]	EPC C_{PLANT} [c] (mg/kg)	Measured Plant Concentration [d] (mg/kg)	BAF_{S-I} [b]	EPC C_{INVERT} [c] (mg/kg)	BAF_{S-V} [b]	EPC $C_{VERTEBRATE}$ [c] (mg/kg)	Ingestion Dose [e] (mg/kg-day)	TRV NOAEL (mg/kg-day)	TRV LOAEL (mg/kg-day)	Ecological Hazard High	Ecological Hazard Low
Aluminum	NA	0.0990	NA	NA	NA	NA	NA	NA	NA	1.1E-03	1.9E+00	1.9E+01	0.00056	0.000056
Antimony	1.04	NA	Regression	0.0410	5.41	1	1.04	0.05	0.0521	9.3E-03	5.9E-02	5.9E-01	0.16	0.016
Arsenic	8.20	NA	0.0375	0.308	NA	Regression	1.07	Regression	0.0440	1.3E-02	1.0E+00	1.7E+00	0.013	0.0081
Cadmium	13.6	0.000100	Regression	2.59	0.461	Regression	66.1	Regression	0.977	1.2E-01	7.7E-01	9.1E-01	0.15	0.13
Chromium	108	NA	0.041	4.42	NA	0.306	33.0	Regression	7.21	4.8E-01	2.4E+00	2.8E+00	0.20	0.17
Copper	27.0	NA	Regression	7.14	NA	0.515	13.9	Regression	12.4	5.9E-01	5.6E+00	6.8E+00	0.10	0.086
Molybdenum	7.94	NA	0.25	1.99	2.09	1	7.94	1	7.94	3.6E-01	2.6E-01	2.6E+00	**1.4**	0.14
Nickel	69.8	0.00129	Regression	2.59	NA	1	69.8	Regression	5.65	4.0E-01	1.7E+00	2.7E+00	0.23	0.15
Selenium	6.67	0.000579	Regression	4.13	0.66	Regression	3.73	Regression	1.35	7.0E-02	1.4E-01	1.5E-01	0.49	0.48
Thallium	0.510	NA	0.0040	0.00204	0.0113	1	0.510	0.1124	0.0573	3.6E-03	3.7E-03	3.7E-02	0.97	0.097
Uranium	10.2	0.000529	0.0085	0.0863	0.162	1	10.2	1	10.2	4.6E-01	3.1E+00	6.1E+00	0.15	0.075
Vanadium	93.3	0.00140	0.00485	0.452	NA	0.042	3.92	0.012	1.15	1.7E-01	4.2E+00	5.1E+00	0.041	0.033
Zinc	473	0.00525	Regression	146	NA	Regression	645	Regression	121	6.5E+00	7.5E+01	7.6E+01	0.086	0.086

Notes:
BAF_{S-P} - bioaccumulation factor from soil to plants
BAF_{S-I} - bioaccumulation factor from soil to invertebrates
BAF_{S-V} - bioaccumulation factor from soil to terrestrial vertebrates
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
LOAEL - lowest observed adverse effects level
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
na - not available
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	13.6	kg
Food Ingestion Rate (FIR):	4.2861	kg (dry wt)/day
FIR_Plants (2%):	0.0857	kg (dry wt)/day
FIR_Inverts (2%):	0.0857	kg (dry wt)/day
FIR_Terrestrial Vertebrates (96%):	4.1147	kg (dry wt)/day
FIR_Soil (2.8%):	0.1200	kg (dry wt)/day
Water Ingestion Rate:	1.0371	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	0.1423	unitless
Home range:	7,240	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier II Background Ecological Risk Assessment are equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration measured in samples collected from Background locations. The measured plant concentration is equal to either the recommended 95%, 97.5%, or
[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 and A4-15.
[c] The plant (C_{PLANT}), terrestrial invertebrate (C_{INVERT}), and terrestrial vertebrate ($C_{VERTEBRATE}$) concentrations were calculated from the soil concentration and the soil-to-biota bioconcentration factors.
[d] The measured plant concentration is equal to either the recommended 95%, 97.5%, or 99% upper confidence limit on the mean concentration or the maximum detected concentration detected in plant tissue collected from background locations.
[e] The ingestion dose for the coyote accounts for exposure to soil based upon terrestrial foraging habits as presented in Appendix Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from upland soil.

Table I-9
Tier II Background Ecological Hazard Calculations for the Great Blue Heron

Constituent	EPC [a] C_{RIP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	EPC [a] $C_{SEDIMENT}$ (mg/kg)	BAF_{S-I} [b]	EPC C_{INVERT} [c] (mg/kg)	BAF_{S-V} [b]	EPC $C_{VERTEBRATES}$ [c] (mg/kg)	BCF_{Sed-F} [b]	BCF_{W-F} [b]	EPC C_{FISH} [c,d] (mg/kg)	Ingestion Dose [e] (mg/kg-day)	TRV NOAEL (mg/kg-day)	TRV LOAEL (mg/kg-day)	Ecological Hazard High	Ecological Hazard Low
Aluminum	NA	0.0990	NA	NA	NA	NA	NA	1.0	13.5	1.34	6.7E-02	1.1E+02	na	0.00061	na
Antimony	5.50	NA	5.00	1	5.50	0.05	0.275	1	200	5.00	2.8E-01	na	na	na	na
Arsenic	NA	0.0007349	4.55	Regression	NA	NA	NA	0.012	570	0.419	2.2E-02	2.2E+00	3.6E+00	0.0096	0.006
Cadmium	2.81	0.000100	2.29	Regression	18.8	Regression	0.463	0.785	4,535	0.454	1.7E-01	1.5E+00	2.4E+00	0.12	0.073
Chromium	27.9	0.000775	26.3	0.306	8.53	Regression	2.67	0.0430	95	0.0736	1.0E-01	2.7E+00	2.8E+00	0.038	0.037
Copper	18.5	NA	25.5	0.515	9.54	Regression	11.7	1	3,550	25.5	1.4E+00	4.1E+00	4.7E+00	0.34	0.29
Molybdenum	0.508	NA	NA	1	0.508	1	0.508	1	1	NA	7.9E-03	3.5E+00	3.5E+01	0.0023	0.00022
Nickel	20.2	0.00129	19.7	1	20.2	Regression	3.17	1	390	0.503	2.1E-01	6.7E+00	1.2E+01	0.032	0.019
Selenium	1.12	0.000579	1.01	Regression	1.01	Regression	0.688	1	645	0.37	3.1E-02	2.9E-01	3.7E-01	0.11	0.084
Thallium	0.333	0.000150	0.378	1	0.333	0.1124	0.0374	1	50,000	7.50	3.5E-01	3.5E-01	3.5E+00	1.0	0.10
Uranium	2.91	0.000529	2.37	1	2.91	1	2.91	1	1	0.000529	4.6E-02	1.6E+01	na	0.0029	na
Vanadium	37.0	0.00140	33.0	0.042	1.55	0.0123	0.455	1	1	0.00140	3.0E-02	3.4E-01	4.1E-01	0.088	0.073
Zinc	117	0.00525	107	Regression	408	Regression	110	1.833	10,295	54.0	6.6E+00	6.6E+01	6.7E+01	0.10	0.099

Notes:

BAF_{S-I} - bioaccumulation factor from soil to terrestrial invertebrates
BAF_{S-V} - bioaccumulation factor from soil to terrestrial vertebrates (birds and mammals)
BAF_{Sed-F} - bioaccumulation factor from sediment to fish
BAF_{W-F} - bioaccumulation factor from water to fish
C_{RIP_SOIL} - Riparian Soil Concentration
$C_{SEDIMENT}$ - Sediment Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
LOAEL - lowest observed adverse effects level
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
ND - not detected
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Body Weight:	2.336	kg
Food Ingestion Rate (FIR):	0.145	kg (dry wt)/day
FIR_Terrestrial Inverts (12.5%):	0.0182	kg (dry wt)/day
FIR_Terrestrial Vertebrates (12.5%):	0.0182	kg (dry wt)/day
FIR_Upland Soil (0%):	0	kg (dry wt)/day
FIR_Fish (75%):	0.11	kg (dry wt)/day
FIR_Riparian Soil (0%):	0	kg (dry wt)/day
FIR_Sediment (0.7%):	0.00102	kg (dry wt)/day
Water Ingestion Rate:	0.104	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	11	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier II Background Ecological Risk Assessment are equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration measured in samples collected from Background locations. Exposure point concentrations are shown for both surface water and sediment for

[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 through A4-15.

[c] The terrestrial invertebrate (C_{INVERT}), terrestrial vertebrate ($C_{VERTIBRATE}$), and aquatic invertebrate (C_{FISH}) concentrations were calculated from the soil, sediment, or surface water concentration and the soil-, sediment-, or surface water-to-biota bioconcentration factors.

[d] The aquatic invertebrate EPC is calculated using the sediment to invertebrate BAF for analytes detected in sediment; otherwise the aquatic invertebrate EPC is based on the water to invertebrate BAF. The fish EPC is calculated using the water to fish BAF for analytes detected in surface water; otherwise the fish EPC is based on the sediment to fish BAF.

[e] The ingestion dose for the great blue heron accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16.

Table I-10
Tier II Background Ecological Hazard Calculations for the Northern Harrier

Constituent	EPC [a] C_{UP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	BAF_{S-I} [b]	EPC C_{INVERT} [c] (mg/kg)	BAF_{S-V} [b]	EPC $C_{VERTEBRATES}$ [c] (mg/kg)	Ingestion Dose [d] (mg/kg-day)	TRV NOAEL (mg/kg-day)	TRV LOAEL (mg/kg-day)	Ecological Hazard High	Ecological Hazard Low
Aluminum	NA	0.0990	NA	NA	NA	NA	7.6E-03	1.1E+02	na	0.000069	na
Antimony	1.04	NA	1	1.04	0.05	0.0521	8.6E-03	na	na	na	na
Arsenic	8.20	NA	Regression	1.07	Regression	0.0440	1.3E-02	2.2E+00	3.6E+00	0.0059	0.0037
Cadmium	13.6	0.000100	Regression	66.1	Regression	0.977	2.6E-01	1.5E+00	2.4E+00	0.18	0.11
Chromium	108	NA	0.306	33.0	Regression	7.21	9.2E-01	2.7E+00	2.8E+00	0.35	0.33
Copper	27.0	NA	0.515	13.9	Regression	12.4	1.4E+00	4.1E+00	4.7E+00	0.34	0.29
Molybdenum	7.94	NA	1	7.94	1	7.94	8.7E-01	3.5E+00	3.5E+01	0.25	0.025
Nickel	69.8	0.00129	1	69.8	Regression	5.65	8.1E-01	6.7E+00	1.2E+01	0.12	0.070
Selenium	6.67	0.000579	Regression	3.73	Regression	1.35	1.6E-01	2.9E-01	3.7E-01	0.54	0.43
Thallium	0.510	NA	1	0.510	0.1124	0.0573	7.6E-03	3.5E-01	3.5E+00	0.022	0.0022
Uranium	10.2	0.000529	1	10.2	1	10.2	1.1E+00	1.6E+01	na	0.069	na
Vanadium	93.3	0.00140	0.042	3.92	0.0123	1.15	2.0E-01	3.4E-01	4.1E-01	0.59	0.49
Zinc	473	0.00525	Regression	645	Regression	121	1.5E+01	6.6E+01	6.7E+01	0.22	0.22

Notes:

BAF_{S-I} - bioaccumulation factor from soil to terrestrial invertebrates
BAF_{S-V} - bioaccumulation factor from soil to terrestrial vertebrates
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
LOAEL - lowest observed adverse effects level
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
NA - not applicable
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	0.449	kg
Food Ingestion Rate (FIR):	0.049	kg (dry wt)/day
FIR_Terrestrial Inverts (2%):	0.0010	kg (dry wt)/day
FIR_Terrestrial Vertebrates (98%):	0.0477	kg (dry wt)/day
FIR_Upland Soil (0.7%):	0.00034	kg (dry wt)/day
Water Ingestion Rate:	0.034	L/day
Exposure Duration (ED):	1	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	642	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier II Background Ecological Risk Assessment are equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration measured in samples collected from Background locations.
[b] The abiotic media-to-biota bioconcentration factors were derived from sources listed in Table A4-13 and A4-15.
[c] The terrestrial invertebrate (C_{INVERT}) and terrestrial vertebrate ($C_{VERTIBRATE}$) concentrations were calculated from the soil concentration and the soil-to-biota bioconcentration factors.
[d] The ingestion dose for the northern harrier accounts for exposure to soil based upon terrestrial foraging habits as presented in Appendix A4-13 and A4-15.

ATTACHMENT J – HENRY SITE AND BACKGROUND LIVESTOCK HAZARD CALCULATIONS

Table J-1
Tier I Henry Site Livestock Hazard Calculations for Beef Cattle

Constituent	EPC [a] C_{UP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	BAF_{S-P} [b]	EPC C_{PLANT} [c] (mg/kg)	Measured Plant Concentration [d] (mg/kg)	Ingestion Dose [e] (mg/kg-day)	TRV NOAEL (mg/kg-day)	Ecological Hazard
Aluminum	NA	0.905	NA	NA	NA	1.6E-02	1.9E+00	0.0082
Antimony	9.15	NA	Regression	0.315	0.518	5.3E-03	5.9E-02	0.090
Arsenic	45.5	NA	0.0375	1.71	10.2	8.4E-02	1.0E+00	0.081
Barium	NA	0.0810	NA	NA	NA	1.4E-03	5.2E+01	0.000027
Boron	39.0	0.121	4.0	156	47.3	3.7E-01	2.8E+01	0.013
Cadmium	59.5	0.0352	Regression	5.79	5.56	5.2E-02	7.7E-01	0.067
Chromium	519	NA	0.041	21.3	18.2	2.2E-01	2.4E+00	0.090
Cobalt	NA	0.0141	NA	NA	NA	2.5E-04	7.3E+00	0.000034
Copper	172	NA	Regression	14.8	15.4	1.4E-01	5.6E+00	0.026
Manganese	NA	2.44	0.079	NA	NA	4.3E-02	5.2E+01	0.0008
Mercury	0.503	NA	Regression	0.265	0.0687	6.0E-04	1.0E+00	0.00059
Molybdenum	35.7	NA	0.25	8.93	125	9.5E-01	2.6E-01	**3.7**
Nickel	425	1.26	Regression	10.0	17.4	2.2E-01	1.7E+00	0.13
Selenium	318	0.970	Regression	294	146	1.2E+00	1.4E-01	**8.2**
Silver	7.30	NA	0.014	0.102	0.164	2.4E-03	6.0E+00	0.00039
Thallium	2.31	NA	0.004	0.00924	0.713	5.8E-03	3.7E-03	**1.6**
Uranium	74.4	0.0206	0.0085	0.632	1.27	2.1E-02	3.1E+00	0.0069
Vanadium	584	0.0885	0.00485	2.83	13.1	1.9E-01	4.2E+00	0.046
Zinc	1,610	4.73	Regression	289	231	2.1E+00	7.5E+01	0.028

Notes:
BAF_{S-P} - bioaccumulation factor from soil to plants
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
mg/L - milligrams per liter
NA - not applicable
na - not available
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	510	kg
Food Ingestion Rate (FIR):	11.77	kg (dry wt)/day
FIR_Plants (100%):	11.77	kg (dry wt)/day
FIR_Soil (2%):	0.2354	kg (dry wt)/day
Water Ingestion Rate:	27.1	L/day
Exposure Duration (ED):	0	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	--	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier I Henry Site Livestock Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at Henry Site locations.
[b] The soil-to-plant bioconcentration factor was derived from sources listed in Table A4-13 and A4-15.
[c] The plant concentration (C_{PLANT}) was calculated from the upland soil concentration and the soil-to-plant bioconcentration factor (BCF_{S-P}).
[d] The measured plant concentration is equal to the maximum concentration detected in plant tissue collected from Henry Site.
[e] The ingestion dose for beef cattle accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from upland soil.

Table J-2
Tier I Background Livestock Hazard Calculations for Beef Cattle

Constituent	EPC [a] C_{UP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	BAF_{S-P} [b]	EPC C_{PLANT} [c] (mg/kg)	Measured Plant Concentration [d] (mg/kg)	Ingestion Dose [e] (mg/kg-day)	TRV NOAEL (mg/kg-day)	Ecological Hazard
Aluminum	NA	0.410	NA	NA	NA	7.2E-03	1.9E+00	0.0037
Antimony	3.60	NA	Regression	0.131	5.41	4.2E-02	5.9E-02	0.70
Arsenic	19.0	NA	0.0375	0.713	na	8.3E-03	1.0E+00	0.0080
Barium	NA	0.0850	NA	NA	NA	1.5E-03	5.2E+01	0.000029
Boron	25.0	0.0200	4.0	100	68.3	5.2E-01	2.8E+01	0.019
Cadmium	44.0	0.000100	Regression	4.91	1.95	2.1E-02	7.7E-01	0.028
Chromium	420	NA	0.041	17.2	na	1.9E-01	2.4E+00	0.081
Copper	82.0	NA	Regression	11.1	na	9.6E-02	5.6E+00	0.017
Manganese	NA	0.0484	0.079	NA	NA	8.4E-04	5.2E+01	0.000016
Mercury	0.320	NA	Regression	0.208	0.0876	7.1E-04	1.0E+00	0.00071
Molybdenum	29.0	NA	0.25	7.25	8.91	7.2E-02	2.6E-01	0.28
Nickel	230	0.00221	Regression	6.33	na	8.3E-02	1.7E+00	0.049
Selenium	29.0	0.00100	Regression	20.9	7.28	6.0E-02	1.4E-01	0.42
Silver	2.40	NA	0.014	0.0336	0.598	4.9E-03	6.0E+00	0.00081
Thallium	1.30	NA	0.004	0.00520	0.0257	3.9E-04	3.7E-03	0.11
Uranium	42.0	0.00120	0.0085	0.357	0.162	7.6E-03	3.1E+00	0.0025
Vanadium	370	0.00620	0.00485	1.79	na	7.0E-02	4.2E+00	0.017
Zinc	1,200	0.0150	Regression	245	na	2.0E+00	7.5E+01	0.027

Notes:

BAF_{S-P} - bioaccumulation factor from soil to plants
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
mg/L - milligrams per liter
NA - not applicable
na - not available
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	510	kg
Food Ingestion Rate (FIR):	11.8	kg (dry wt)/day
FIR_Plants (100%):	11.8	kg (dry wt)/day
FIR_Soil (2%):	0.235	kg (dry wt)/day
Water Ingestion Rate:	27.1	L/day
Exposure Duration (ED):	0	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	--	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier I Background Livestock Risk Assessment are equal to the maximum detected concentrations measured in samples collected from those media at background locations.

[b] The soil-to-plant bioconcentration factor was derived from sources listed in Table A4-13 and A4-15.

[c] The plant concentration (C_{PLANT}) was calculated from the upland soil concentration and the soil-to-plant bioconcentration factor (BCF_{S-P}).

[d] The measured plant concentration is equal to the maximum concentration detected in plant tissue collected from background locations.

[e] The ingestion dose for beef cattle accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from upland soil.

Table J-3
Tier II Henry Site Livestock Hazard Calculations for Beef Cattle

Constituent	EPC [a] C_{UP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	$BAF_{S\text{-}P}$ [b]	EPC C_{PLANT} [c] (mg/kg)	Measured Plant Concentration [d] (mg/kg)	Ingestion Dose [e] (mg/kg-day)	TRV NOAEL (mg/kg-day)	TRV LOAEL (mg/kg-day)	Ecological Hazard High	Ecological Hazard Low
Molybdenum	16.8	NA	0.25	4.21	19.9	1.5E-01	2.6E-01	2.6E+00	0.59	0.059
Selenium	46.4	0.102	Regression	35.2	16.4	1.3E-01	1.4E-01	1.5E-01	0.93	0.92
Thallium	1.31	NA	0.004	0.00522	0.239	2.0E-03	3.7E-03	3.7E-02	0.54	0.054

Notes:

$BAF_{S\text{-}P}$ - bioaccumulation factor from soil to plants
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
LOAEL - lowest obsesrved adverse effects level
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
mg/L - milligrams per liter
NA - not applicable
na - not available
ND - not detected
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	510	kg
Food Ingestion Rate (FIR):	11.8	kg (dry wt)/day
FIR_Plants (100%):	11.8	kg (dry wt)/day
FIR_Soil (2%):	0.235	kg (dry wt)/day
Water Ingestion Rate:	27.1	L/day
Exposure Duration (ED):	0.33	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	--	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier II Henry Site Livestock Risk Assessment are equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration measured in samples collected from the Henry Site.

[b] The soil-to-plant bioconcentration factor was derived from sources listed in Table A4-13 and A4-15.

[c] The plant concentration (C_{PLANT}) was calculated from the upland soil concentration and the soil-to-plant bioconcentration factor ($BCF_{S\text{-}P}$).

[d] The measured plant concentration is equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration detected in plant tissue collected from Henry Site.

[e] The ingestion dose for beef cattle accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from upland soil.

Table J-4
Tier II Background Livestock Hazard Calculations for Beef Cattle

Constituent	EPC [a] C_{UP_SOIL} (mg/kg)	EPC [a] C_{WATER} (mg/L)	$BAF_{S\text{-}P}$ [b]	EPC C_{PLANT} [c] (mg/kg)	Measured Plant Concentration [d] (mg/kg)	Ingestion Dose [e] (mg/kg-day)	TRV NOAEL (mg/kg-day)	TRV LOAEL (mg/kg-day)	Ecological Hazard High	Ecological Hazard Low
Molybdenum	7.94	NA	0.25	1.99	2.09	1.7E-02	2.6E-01	2.6E+00	0.066	0.0066
Selenium	6.67	0.000579	Regression	4.13	0.662	6.0E-03	1.4E-01	1.5E-01	0.042	0.042
Thallium	0.510	NA	0.004	0.00204	0.0113	1.6E-04	3.7E-03	3.7E-02	0.044	0.0044

Notes:

$BAF_{S\text{-}P}$ - bioaccumulation factor from soil to plants
C_{UP_SOIL} - Upland Soil Concentration
C_{WATER} - Surface Water Concentration
EPC - exposure point concentration
HI - hazard index
HQ - hazard quotient
LOAEL - lowest observed adverse effects level
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day
mg/L - milligrams per liter
NA - not applicable
na - not available
NOAEL - no observed adverse effects level
TRV - toxicity reference value

Exposure Parameters

Body Weight:	510	kg
Food Ingestion Rate (FIR):	11.8	kg (dry wt)/day
FIR_Plants (100%):	11.8	kg (dry wt)/day
FIR_Soil (2%):	0.235	kg (dry wt)/day
Water Ingestion Rate:	27.1	L/day
Exposure Duration (ED):	0.33	unitless
Site Utilization Factor (SUF):	1	unitless
Home range:	--	acres
Exposure area:	1,030	acres

[a] The abiotic media exposure point concentrations used in the Tier II Background Livestock Risk Assessment are equal to either the ProUCL recommended 95%, 97.5% or 99% upper confidence limit on the mean concentration or the maximum detected concentration measured in samples collected from Background locations.
[b] The soil-to-plant bioconcentration factor was derived from sources listed in Table A4-13 and A4-15.
[c] The plant concentration (C_{PLANT}) was calculated from the upland soil concentration and the soil-to-plant bioconcentration factor ($BCF_{S\text{-}P}$).
[d] The measured plant concentration is equal to either the recommended 95%, 97.5%, or 99% upper confidence limit on the mean concentration or the maximum detected concentration detected in plant tissue collected from background locations.
[e] The ingestion dose for beef cattle accounts for exposure to soil based upon terrestrial foraging habits as presented in Table A4-16, and uses measured plant tissue concentrations, where available, in preference to plant tissue concentrations modeled from upland soil.

APPENDIX B

REMEDIAL INVESTIGATION ANALYTICAL DATA

TABLE B-1a

SUMMARY OF UPLAND SOIL RESULTS - HENRY SITE
P4 RI/FS

Analyte/Methods (Units)	Location Identification Field Sample Identification Date Collected	MBH002-01 0906-MBH002-01-SS 6/18/2009	MBH002-02 0906-MBH002-02-SS 6/18/2009	MBH002-03 0906-MBH002-03-SS 6/18/2009	MBH002-04 0906-MBH002-04-SS 6/18/2009	MBH002-05 0906-MBH002-05-SS 6/18/2009	MBH002-06 0906-MBH002-06-SS 6/17/2009
Metals (mg/kg)	**Background Limits mg/kg**						
Antimony	3.6	**0.53 F**	<0.375	<0.38	<0.378	**0.423 F**	<0.373
Arsenic	15.6	**8.1**	**8.25**	**7.47**	**9.01**	**8.0**	**7.15**
Boron	25	**22.3 J-**	**18.6 J-**	**15.7 J-**	**15.4 J-**	**13**	**1.92 F**
Cadmium	41	**0.881**	**1.15**	**1.1**	**0.79**	**0.997 J+**	**0.572**
Chromium, Total	410	**20.7 J-**	**22.6 J-**	**23.1 J-**	**20.9 J-**	**20.5**	**22.5 J**
Cobalt	13	**10.7**	**12.4**	**11.1**	**10.7**	**13.1 J-**	**11.9**
Copper	51.9	**24**	**25.1**	**24.7**	**23.6**	**28.7**	**21.2**
Manganese	3460	**2120**	**2840**	**2540**	**2190**	**1890**	**2730**
Mercury	0.32	**0.0261 F**	**0.0319 F**	**0.0425 F**	**0.0276 F**	**0.0263 F,J-**	**0.015 F**
Molybdenum	29	<1.14	<1.13	<1.14	<1.13	<1.12	<1.12 UJ
Nickel	220	**23.8 J-**	**27.2 J-**	**25.4 J-**	**24.2 J-**	**26.2**	**26.1**
Selenium	29	**0.643 F**	**1.26**	**1.02**	**0.874 F**	**0.736 F,J**	**0.626**
Silver	1.7	<0.242	<0.249	<0.249	<0.248	<0.247	**0.104 F**
Thallium	1.1	**0.154**	**0.152**	**0.144**	**0.155**	**0.139**	**0.154**
Uranium	36	<0.484	**0.509 F**	**0.559 F**	<0.495	**0.571 F,J+**	**0.416**
Vanadium	300	**26.2**	**26.6**	**26.5**	**27.1**	**22.9**	**25**
Zinc	1200	**63.1 J**	**78.3 J**	**65 J**	**61.6 J**	**75.5 J**	**93.1 J**
Chemistry Parameters							
Chromium, Hexavalent (mg/kg)	--	<0.249	<0.496	<0.498	<0.495	<0.25	<0.248
Total solids (Percent)	--	--	--	--	--	--	--

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

SUMMARY OF UPLAND SOIL RESULTS - HENRY SITE
P4 RI/FS

Location Identification		MBH002-07	MBH002-07 Dup	MBH002-07 Triplicate	MBH002-07 Average	MBH002-08	MBH002-09	MBH002-10
Field Sample Identification		0906-MBH002-07-SS-1	0906-MBH002-07-SS-2	0906-MBH002-07-SS-3	0906-MBH002-07-SS-avg	0906-MBH002-08-SS	0906-MBH002-09-SS	0906-MBH002-10-SS
Date Collected		6/16/2009	6/16/2009	6/16/2009	6/16/2009	6/18/2009	6/16/2009	6/18/2009
Analyte/Methods (Units)								
Metals (mg/kg)	**Background Limits mg/kg**							
Antimony	3.6	<0.755	<0.368	<0.359	<0.755	**0.469 F**	<0.747	<0.366
Arsenic	15.6	**9.47 J+**	**8.37 J+**	**7.95 J+**	**8.597 J+**	**8.58**	**6.6 J+**	**7.24**
Boron	25	**4.12**	**8.57**	**8.69**	**7.127**	**12.8**	**4.71**	**13.8**
Cadmium	41	**0.818 J+**	**0.983 J+**	**1.08 J+**	**0.9603 J+**	**0.746 J+**	**0.858 J+**	**0.792 J+**
Chromium, Total	410	**22.5**	**23.4**	**19.2**	**21.7**	**17.2**	**20.5**	**20.7**
Cobalt	13	**12.1**	**11.2**	**11.3**	**11.53**	**9.23 J-**	**13.3**	**11.9 J-**
Copper	51.9	**24.9**	**24.6**	**23.5**	**24.33**	**21.3**	**21.6**	**23.6**
Manganese	3460	**2600 J**	**2600 J**	**2700 J**	**2633.3 J**	**1500**	**3990 J**	**2920**
Mercury	0.32	**0.0217 F**	**0.024 F**	**0.0262 F**	**0.02397 F**	**0.0225 F,J-**	**0.0231 F**	**0.0243 F,J-**
Molybdenum	29	<1.13	<1.1	<1.08	<1.13	<1.15	<1.12	<1.1
Nickel	220	**27.1**	**25.9**	**24.2**	**25.73**	**22.8**	**26.7**	**26.6**
Selenium	29	**0.745 F,J+**	**0.666 F,J+**	**0.741 F,J+**	**0.7173 F,J+**	**0.477 J**	**0.863 F,J+**	**0.677 F,J**
Silver	1.7	<0.248	<0.249	<0.24	<0.249	**0.11 F**	<0.25	<0.247
Thallium	1.1	**0.161**	**0.177**	**0.15**	**0.1627**	**0.15**	**0.152**	**0.144**
Uranium	36	**0.689 F**	**0.564 F**	<0.48	**0.6265 F**	**0.395 J+**	<0.5	<0.494
Vanadium	300	**27.1**	**28.1**	**23.7**	**26.3**	**22.4**	**22.2**	**23**
Zinc	1200	**79.7**	**78.1**	**78.6**	**78.8**	**57.7 J**	**84.1**	**66 J**
Chemistry Parameters								
Chromium, Hexavalent (mg/kg)	--	<0.479 UJ	<0.246 UJ	<0.498 UJ	<0.498 UJ	<0.499	<0.488 UJ	<0.486
Total solids (Percent)	--	--	--	--	--	--	--	--

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

SUMMARY OF UPLAND SOIL RESULTS - HENRY SITE
P4 RI/FS

Analyte/Methods (Units)	Location Identification / Field Sample Identification / Date Collected	MHR002 0906-MHR002-01-SS 6/18/2009	MHR002 0906-MHR002-02-SS 6/18/2009	MHR002 0906-MHR002-03-SS 6/19/2009	MHR002 0906-MHR002-04-SS 6/19/2009	MHR002 0906-MHR002-05-SS 6/18/2009	MHR002 0906-MHR002-06-SS 6/18/2009
Metals (mg/kg)	**Background Limits mg/kg**						
Antimony	3.6	**2.83 F**	**3.64 F**	**2.17**	**2.06**	**2.56 F**	**1.65**
Arsenic	15.6	**14.4**	**13.2**	**8.9**	**16.1**	**7.26**	**10.5**
Boron	25	**12.2 F**	**17.9 F**	**3.28 F,J-**	**11.4 J-**	**16.8 F,J-**	**8.33 J-**
Cadmium	41	**19.4 J+**	**20.6 J+**	**29.3**	**32.9**	**37.4**	**31.3**
Chromium, Total	410	**141**	**170**	**90.8 J+**	**195 J+**	**136 J-**	**70.2 J-**
Cobalt	13	**7.04 J-**	**4.4 J-**	**5.32**	**3.17**	**3.2**	**3.24**
Copper	51.9	**68.4**	**65.4**	**44**	**40.8**	**30**	**22.9**
Manganese	3460	**410**	**447**	**939**	**148**	**204**	**230**
Mercury	0.32	**0.192 F,J-**	**0.194 F,J-**	**0.0967 F**	**0.116 F**	**0.0858 F**	**0.0603 F**
Molybdenum	29	**11.9**	**10.8 F**	**4.46**	**3.87**	**6.5 F**	**4.58**
Nickel	220	**139**	**128**	**102**	**106**	**126 J-**	**143 J-**
Selenium	29	**21.1 J**	**19 J**	**8.05 J**	**12.7 J**	**9.27**	**7.45**
Silver	1.7	**2.36**	**2.64**	**1.82**	**2.04**	**1.61**	**0.914 F**
Thallium	1.1	**0.839**	**0.851**	**1.17**	**1.53**	**1.71**	**1.74**
Uranium	36	**23.3 J+**	**29.8 J+**	**32.8**	**38.6**	**36.6**	**19.1**
Vanadium	300	**110**	**145**	**160 J+**	**234 J+**	**149**	**117**
Zinc	1200	**536 J**	**549 J**	**458 J-,B**	**407 J-,B**	**850 J**	**702 J**
Chemistry Parameters							
Chromium, Hexavalent (mg/kg)	--	<0.249	<0.498	<0.498	<0.493	<0.245	<0.499
Total solids (Percent)	--	--	--	--	--	--	--

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

TABLE B-1a

SUMMARY OF UPLAND SOIL RESULTS - HENRY SITE
P4 RI/FS

Location Identification		MHR002	MHR002 Dup	MHR002 Triplicate	MHR002 Average	MHR002	MHR002	MHR002
Field Sample Identification		0906-MHR002-07-SS-1	0906-MHR002-07-SS-2	0906-MHR002-07-SS-3	0906-MHR002-07-SS-avg	0906-MHR002-08-SS	0906-MHR002-09-SS	0906-MHR002-10-SS
Date Collected		6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009
Analyte/Methods (Units)								
Metals (mg/kg)	**Background Limits mg/kg**							
Antimony	3.6	**9.68**	**2.1**	**1.06**	**4.28**	**7.23**	**8.18**	**5.71**
Arsenic	15.6	**19.2**	**15.4**	**7.3**	**13.97**	**33.4**	**45.5**	**26.1**
Boron	25	**30.2 J-**	**9.97 J-**	**10.7 J-**	**16.957 J-**	**27.5 J-**	**28.5 J-**	**39 J-**
Cadmium	41	**114**	**54**	**10.4**	**59.47**	**32.4**	**39.4**	**34.1**
Chromium, Total	410	**627 J-**	**134 J-**	**42.6 J-**	**267.87 J-**	**332 J-**	**171 J-**	**139 J-**
Cobalt	13	**3.05**	**9.37**	**6.49**	**6.303**	**8.51**	**11.7**	**8.48**
Copper	51.9	**92**	**57**	**20.7**	**56.57**	**135**	**168**	**134**
Manganese	3460	**140**	**808**	**481**	**476.3**	**197**	**228**	**186**
Mercury	0.32	**0.259**	**0.0726 F**	**0.0516 F**	**0.12773 F**	**0.47**	**0.477**	**0.373**
Molybdenum	29	**9.19 F**	**3.03**	**3.05**	**5.09 F**	**28.7**	**25.2**	**10.4 F**
Nickel	220	**124 J-**	**145 J-**	**50.3 J-**	**106.43 J-**	**293 J-**	**167 J-**	**78.5 J-**
Selenium	29	**16.6**	**10.5**	**2.94**	**10.013**	**57.1**	**47.6**	**21.6**
Silver	1.7	**4.4**	**2.22**	**0.634 F**	**2.418 F**	**5.89**	**5.27**	**3.89**
Thallium	1.1	**3.64**	**2.48**	**0.531**	**2.217**	**1.15**	**1.46**	**2.03**
Uranium	36	**151**	**59.5**	**12.7**	**74.4**	**36.6**	**46**	**45.9**
Vanadium	300	**1370**	**240**	**58.6**	**556.2**	**199**	**110**	**77.1**
Zinc	1200	**910 J**	**422 J**	**216 J**	**516 J**	**920 J**	**944 J**	**511 J**
Chemistry Parameters								
Chromium, Hexavalent (mg/kg)	--	<0.243	<0.498	<0.496	<0.498	<0.249	<0.249	<0.498
Total solids (Percent)	--	--	--	--	--	--	--	--

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

TABLE B-1a

SUMMARY OF UPLAND SOIL RESULTS - HENRY SITE
P4 RI/FS
(Page 5 of 20)

Analyte/Methods (Units)	Location Identification / Field Sample Identification / Date Collected	MWD085 SSMWD085-1-C(5) 7/21/2004	MWD085 SSMWD085-2-C(5) 7/21/2004	MWD085 SSMWD085-3-C(5) 7/21/2004	MWD085 SSMWD085-4-C(5) 7/21/2004	MWD085 SSMWD085-5-C(5) 7/21/2004	MWD085 SSMWD085-6-C(5) 7/21/2004	MWD085 SSMWD085-7-C(6) 7/21/2004	MWD085 SSMWD085-8-C(6) 7/21/2004
Metals (mg/kg)	**Background Limits mg/kg**								
Antimony	3.6	--	--	--	--	--	--	--	--
Arsenic	15.6	--	--	--	--	--	--	--	--
Boron	25	--	--	--	--	--	--	--	--
Cadmium	41	--	--	--	--	--	--	--	--
Chromium, Total	410	--	--	--	--	--	--	--	--
Cobalt	13	--	--	--	--	--	--	--	--
Copper	51.9	--	--	--	--	--	--	--	--
Manganese	3460	--	--	--	--	--	--	--	--
Mercury	0.32	--	--	--	--	--	--	--	--
Molybdenum	29	--	--	--	--	--	--	--	--
Nickel	220	--	--	--	--	--	--	--	--
Selenium	29	**40 J+**	**38 J+**	**53 J+**	**28 J+**	<0.5	<0.5	<0.5	<0.5
Silver	1.7	--	--	--	--	--	--	--	--
Thallium	1.1	--	--	--	--	--	--	--	--
Uranium	36	--	--	--	--	--	--	--	--
Vanadium	300	--	--	--	--	--	--	--	--
Zinc	1200	--	--	--	--	--	--	--	--
Chemistry Parameters									
Chromium, Hexavalent (mg/kg)	--	--	--	--	--	--	--	--	--
Total solids (Percent)	--	**96.8**	**95.6**	**96.7**	**94.2**	**94.3**	**97.3**	**96.6**	**95.6**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

TABLE B-1a

SUMMARY OF UPLAND SOIL RESULTS - HENRY SITE
P4 RI/FS

Location Identification		MWD085	MWD085	MWD085	MWD085	MWD085	MWD085	MWD085	MWD085
Field Sample Identification		SSMWD085-9-C(5)	SSMWD085-10-C(6)	SSMWD085-11-C(5)	SSMWD085-12-C(6)	SSMWD085-13-C(6)	SSMWD085-14-C(5)	SSMWD085-15-C(5)	SSMWD085-16-C(5)
Date Collected		7/21/2004	7/21/2004	7/21/2004	7/21/2004	7/21/2004	7/22/2004	7/22/2004	7/22/2004
Analyte/Methods (Units)									
Metals (mg/kg)	**Background Limits mg/kg**								
Antimony	3.6	--	--	--	--	--	--	--	--
Arsenic	15.6	--	--	--	--	--	--	--	--
Boron	25	--	--	--	--	--	--	--	--
Cadmium	41	--	--	--	--	--	--	--	--
Chromium, Total	410	--	--	--	--	--	--	--	--
Cobalt	13	--	--	--	--	--	--	--	--
Copper	51.9	--	--	--	--	--	--	--	--
Manganese	3460	--	--	--	--	--	--	--	--
Mercury	0.32	--	--	--	--	--	--	--	--
Molybdenum	29	--	--	--	--	--	--	--	--
Nickel	220	--	--	--	--	--	--	--	--
Selenium	29	<0.5	<0.5	<0.5	<0.5	**0.5 J,B**	**41**	**52**	**41**
Silver	1.7	--	--	--	--	--	--	--	--
Thallium	1.1	--	--	--	--	--	--	--	--
Uranium	36	--	--	--	--	--	--	--	--
Vanadium	300	--	--	--	--	--	--	--	--
Zinc	1200	--	--	--	--	--	--	--	--
Chemistry Parameters									
Chromium, Hexavalent (mg/kg)	--	--	--	--	--	--	--	--	--
Total solids (Percent)	--	**95.7**	**95.6**	**96.8**	**96**	**96.5**	**96.3**	**97**	**96.7**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

TABLE B-1a

SUMMARY OF UPLAND SOIL RESULTS - HENRY SITE
P4 RI/FS
(Page 7 of 20)

Analyte/Methods (Units)	Location Identification / Field Sample Identification / Date Collected	MWD085 SSMWD085-17-C(5) 7/22/2004	MWD085 SSMWD085-18-C(5) 7/22/2004	MWD085 SSMWD085-19-C(5) 7/22/2004	MWD085 SSMWD085-20-C(5) 7/22/2004	MWD085 SSMWD085-21-C(6) 7/22/2004	MWD085 SSMWD085-22-C(5) 7/22/2004	MWD085 SSMWD085-23-C(5) 7/22/2004	MWD085 SSMWD085-24-C(5) 7/22/2004
Metals (mg/kg)	**Background Limits mg/kg**								
Antimony	3.6	--	--	--	--	--	--	--	--
Arsenic	15.6	--	--	--	--	--	--	--	--
Boron	25	--	--	--	--	--	--	--	--
Cadmium	41	--	--	--	--	--	--	--	--
Chromium, Total	410	--	--	--	--	--	--	--	--
Cobalt	13	--	--	--	--	--	--	--	--
Copper	51.9	--	--	--	--	--	--	--	--
Manganese	3460	--	--	--	--	--	--	--	--
Mercury	0.32	--	--	--	--	--	--	--	--
Molybdenum	29	--	--	--	--	--	--	--	--
Nickel	220	--	--	--	--	--	--	--	--
Selenium	29	**42**	**1.5 J,B**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Silver	1.7	--	--	--	--	--	--	--	--
Thallium	1.1	--	--	--	--	--	--	--	--
Uranium	36	--	--	--	--	--	--	--	--
Vanadium	300	--	--	--	--	--	--	--	--
Zinc	1200	--	--	--	--	--	--	--	--
Chemistry Parameters									
Chromium, Hexavalent (mg/kg)	--	--	--	--	--	--	--	--	--
Total solids (Percent)	--	**96.5**	**95.3**	**96**	**95.8**	**96.7**	**94.9**	**95.1**	**95.2**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

TABLE B-1a

SUMMARY OF UPLAND SOIL RESULTS - HENRY SITE
P4 RI/FS

Location Identification / Field Sample Identification / Date Collected / Analyte/Methods (Units)		MWD085 SSMWD085-25-C(6) 7/22/2004	MWD085 SSMWD085-26-C(7)QA1 7/21/2004	MWD085 Dup SSMWD085-26-C(7)QA2 7/21/2004	MWD085 Triplicate SSMWD085-26-C(7)QA3 7/21/2004	MWD085 Quadruplicate SSMWD085-26-C(7)QA4 7/21/2004	MWD085 Average SSMWD085-26-C(7)QA-avg 7/21/2004
Metals (mg/kg)	**Background Limits mg/kg**						
Antimony	3.6	--	--	--	--	--	--
Arsenic	15.6	--	--	--	--	--	--
Boron	25	--	--	--	--	--	--
Cadmium	41	--	--	--	--	--	--
Chromium, Total	410	--	--	--	--	--	--
Cobalt	13	--	--	--	--	--	--
Copper	51.9	--	--	--	--	--	--
Manganese	3460	--	--	--	--	--	--
Mercury	0.32	--	--	--	--	--	--
Molybdenum	29	--	--	--	--	--	--
Nickel	220	--	--	--	--	--	--
Selenium	29	<0.5	<0.5	<0.5	<0.5	--	<0.5
Silver	1.7	--	--	--	--	--	--
Thallium	1.1	--	--	--	--	--	--
Uranium	36	--	--	--	--	--	--
Vanadium	300	--	--	--	--	--	--
Zinc	1200	--	--	--	--	--	--
Chemistry Parameters							
Chromium, Hexavalent (mg/kg)	--	--	--	--	--	--	--
Total solids (Percent)	--	**97.3**	**94.7**	**94.6**	**94.4**	**94.4**	**94.53**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

TABLE B-1a

SUMMARY OF UPLAND SOIL RESULTS - HENRY SITE
P4 RI/FS
(Page 9 of 20)

Location Identification		MWD085	MWD085	MWD085	MWD085	MWD085	MWD085
Field Sample Identification		0906-MWD085-01-SS	0906-MWD085-02-SS	0906-MWD085-03-SS	0906-MWD085-04-SS	0906-MWD085-05-SS	0906-MWD085-06-SS
Date Collected		6/17/2009	6/17/2009	6/16/2009	6/16/2009	6/16/2009	6/23/2009
Analyte/Methods (Units)	**Background Limits mg/kg**						
Metals (mg/kg)							
Antimony	3.6	**7.64**	**5.51**	**5.34**	**2.82 F**	**6.45**	**4.26**
Arsenic	15.6	**36.7**	**29.4**	**36.5**	**22.1**	**32.3**	**25.6**
Boron	25	**24.9 J+**	**25.8 J+**	<9.54	<9.09	<9.43	<9.17
Cadmium	41	**27.9**	**43.7**	**45.5 J+**	**35.5 J+**	**46.6 J+**	**42.2 J+**
Chromium, Total	410	**327 J+**	**281 J+**	**166**	**154**	**244**	**223**
Cobalt	13	**6.74**	**5.81**	**11.9**	**8.14**	**10**	**9.86**
Copper	51.9	**99.3**	**115**	**140**	**92.5**	**147**	**128**
Manganese	3460	**228**	**193**	**490**	**396**	**296**	**320 J**
Mercury	0.32	**0.303**	**0.316**	**0.356**	**0.244 F**	**0.363**	**0.415**
Molybdenum	29	**16.3**	**10.7**	**25.2**	**13.1**	**26.2**	**15.2**
Nickel	220	**254**	**182**	**166**	**148**	**215**	**173**
Selenium	29	**56.6 J**	**29.6 J**	**39.3 J+**	**31.5 J+**	**43.9 J+**	**28.7**
Silver	1.7	**3.41**	**4.43**	**3.71**	**2.5**	**4.95**	**3.23 J-**
Thallium	1.1	**0.953**	**1.33**	**2.08**	**1.44**	**1.56**	**1.86**
Uranium	36	**25.6**	**42.7**	**40 J+**	**37.8 J+**	**41.5 J+**	**35 J-**
Vanadium	300	**218 J+**	**300 J+**	**151**	**148**	**163**	**160**
Zinc	1200	**827**	**587**	**1190**	**928**	**1220**	**857**
Chemistry Parameters							
Chromium, Hexavalent (mg/kg)	--	<0.49	<0.5	<0.979	<0.245	<0.243	<0.489
Total solids (Percent)	--	--	--	--	--	--	--

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

TABLE B-1a

SUMMARY OF UPLAND SOIL RESULTS - HENRY SITE
P4 RI/FS
(Page 10 of 20)

Location Identification / Field Sample Identification / Date Collected / Analyte/Methods (Units)	Background Limits mg/kg	MWD085 0906-MWD085-07-SS-1 6/17/2009	MWD085 Dup 0906-MWD085-07-SS-2 6/17/2009	MWD085 Triplicate 0906-MWD085-07-SS-3 6/17/2009	MWD085 Average 0906-MWD085-07-SS-avg 6/17/2009	MWD085 0906-MWD085-08-SS 6/17/2009	MWD085 0906-MWD085-09-SS 6/17/2009	MWD085 0906-MWD085-10-SS 6/17/2009
Metals (mg/kg)								
Antimony	3.6	<0.377	<0.359	**1.18**	**1.18**	<0.379	**9.15**	**6.98**
Arsenic	15.6	**3.84**	**3.93**	**6.91**	**4.893**	**4.38**	**40.7**	**28.5**
Boron	25	**8.43 J+**	**7.99 J+**	**11.3 J+**	**9.24 J+**	**10.6 J+**	**27.5**	**17.1 F**
Cadmium	41	**3.85**	**3.9**	**19.7**	**9.15**	**3.74**	**25.9**	**32.8**
Chromium, Total	410	**21.7 J+**	**20.5 J+**	**51.5 J+**	**31.23 J+**	**22.2 J+**	**499 J**	**337 J**
Cobalt	13	**6.82**	**7.01**	**7.01**	**6.947**	**7.45**	**5.9**	**7.97**
Copper	51.9	**14.9**	**14.1**	**27.8**	**18.93**	**15.7**	**136**	**123**
Manganese	3460	**613**	**683**	**655**	**650.3**	**941**	**175**	**363**
Mercury	0.32	**0.0251 F**	**0.0158 F**	**0.0599 F**	**0.0336 F**	**0.0259 F**	**0.465**	**0.386**
Molybdenum	29	**1.19 F**	**1.11 F**	**3.31**	**1.87 F**	<1.14	**21.2 J-**	**9.7 F,J-**
Nickel	220	**24.3**	**23.1**	**54**	**33.8**	**26.4**	**282**	**237**
Selenium	29	**1.48 J**	**1.14 J**	**8.55 J**	**3.723 J**	**1.2 J**	**91.8**	**70.3**
Silver	1.7	**0.255**	**0.261**	**1.18**	**0.5653**	**0.224**	**4.6**	**3.88**
Thallium	1.1	**0.297**	**0.317**	**0.799**	**0.471**	**0.232**	**1.08**	**1.7**
Uranium	36	**3.42**	**3.46**	**18.7**	**8.527**	**2.8**	**39.3**	**35.5**
Vanadium	300	**23.6 J+**	**24.5 J+**	**104 J+**	**50.7 J+**	**24.9 J+**	**251**	**263**
Zinc	1200	**156**	**99.7**	**271**	**175.57**	**138**	**841 J**	**693 J**
Chemistry Parameters								
Chromium, Hexavalent (mg/kg)	--	<0.249	<0.249	<0.498	<0.498	<0.492	<0.249	<0.245
Total solids (Percent)	--	--	--	--	--	--	--	--

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

TABLE B-1a

SUMMARY OF UPLAND SOIL RESULTS - HENRY SITE
P4 RI/FS
(Page 11 of 20)

Location Identification Field Sample Identification Date Collected Analyte/Methods (Units)		MWD086 SSMWD086-1-C(16)QA1 7/22/2004	MWD086 Dup SSMWD086-1-C(16)QA2 7/22/2004	MWD086 Triplicate SSMWD086-1-C(16)QA3 7/22/2004	MWD086 Average SSMWD086-1-C(16)QA-avg 7/22/2004	MWD086 SSMWD086-2-C5(5) 7/22/2004	MWD086 SSMWD086-3-C(5) 7/22/2004	MWD086 SSMWD086-4-C(5) 7/22/2004	MWD086 SSMWD086-5-C(5) 7/22/2004
Metals (mg/kg)	**Background Limits mg/kg**								
Antimony	3.6	--	--	--	--	--	--	--	--
Arsenic	15.6	--	--	--	--	--	--	--	--
Boron	25	--	--	--	--	--	--	--	--
Cadmium	41	--	--	--	--	--	--	--	--
Chromium, Total	410	--	--	--	--	--	--	--	--
Cobalt	13	--	--	--	--	--	--	--	--
Copper	51.9	--	--	--	--	--	--	--	--
Manganese	3460	--	--	--	--	--	--	--	--
Mercury	0.32	--	--	--	--	--	--	--	--
Molybdenum	29	--	--	--	--	--	--	--	--
Nickel	220	--	--	--	--	--	--	--	--
Selenium	29	**8.9 J-,B**	**9.8 J-,B**	**9.0 J-,B**	**9.23 J-**	**13.3 J-,B**	**11.2 J-,B**	**0.9 J-,B**	<0.5 UJ
Silver	1.7	--	--	--	--	--	--	--	--
Thallium	1.1	--	--	--	--	--	--	--	--
Uranium	36	--	--	--	--	--	--	--	--
Vanadium	300	--	--	--	--	--	--	--	--
Zinc	1200	--	--	--	--	--	--	--	--
Chemistry Parameters									
Chromium, Hexavalent (mg/kg)	--	--	--	--	--	--	--	--	--
Total solids (Percent)	--	**95.8**	--	--	--	**97.7**	--	--	--

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

TABLE B-1a

SUMMARY OF UPLAND SOIL RESULTS - HENRY SITE
P4 RI/FS

Location Identification		MWD086	MWD086	MWD086	MWD086	MWD086	MWD086	MWD086	MWD086	MWD086
Field Sample Identification		SSMWD086-6-C(5)	SSMWD086-7-C(5)	SSMWD086-8-C(7)	SSMWD086-9-C(6)	SSMWD086-10-C(6)	SSMWD086-11-C(5)	SSMWD086-12-C(6)	SSMWD086-13-C(8)	SSMWD086-14-C(16)
Date Collected		7/22/2004	7/22/2004	7/22/2004	7/22/2004	7/22/2004	7/22/2004	7/22/2004	7/22/2004	7/22/2004
Analyte/Methods (Units)										
Metals (mg/kg)	**Background Limits mg/kg**									
Antimony	3.6	--	--	--	--	--	--	--	--	--
Arsenic	15.6	--	--	--	--	--	--	--	--	--
Boron	25	--	--	--	--	--	--	--	--	--
Cadmium	41	--	--	--	--	--	--	--	--	--
Chromium, Total	410	--	--	--	--	--	--	--	--	--
Cobalt	13	--	--	--	--	--	--	--	--	--
Copper	51.9	--	--	--	--	--	--	--	--	--
Manganese	3460	--	--	--	--	--	--	--	--	--
Mercury	0.32	--	--	--	--	--	--	--	--	--
Molybdenum	29	--	--	--	--	--	--	--	--	--
Nickel	220	--	--	--	--	--	--	--	--	--
Selenium	29	<0.5 UJ	<0.5 UJ	**0.5 J-,B**	**0.6 J-,B**	<0.5	<0.5	<0.5	<0.5	**12.4 J-,B**
Silver	1.7	--	--	--	--	--	--	--	--	--
Thallium	1.1	--	--	--	--	--	--	--	--	--
Uranium	36	--	--	--	--	--	--	--	--	--
Vanadium	300	--	--	--	--	--	--	--	--	--
Zinc	1200	--	--	--	--	--	--	--	--	--
Chemistry Parameters										
Chromium, Hexavalent (mg/kg)	--	--	--	--	--	--	--	--	--	--
Total solids (Percent)	--	--	--	--	--	--	**91**	**89.5**	**89.2**	**87**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

Analyte/Methods (Units)	Location Identification / Field Sample Identification / Date Collected	MWD086 SSMWD086-15-C(9) 7/22/2004	MWD086 SSMWD086-16-C(5) 7/22/2004	MWD086 SSMWD086-17-C(5) 7/22/2004	MWD086 SMWD086-18-C(5) 7/22/2004	MWD086 SSMWD086-19-C(5) 7/22/2004	MWD086 SSMWD086-20-C(5) 7/22/2004	MWD086 SSMWD086-21-C(5) 7/22/2004	MWD086 SSMWD086-22-C(5) 7/22/2004	MWD086 SSMWD086-23-C(5) 7/22/2004
Metals (mg/kg)	**Background Limits mg/kg**									
Antimony	3.6	--	--	--	--	--	--	--	--	--
Arsenic	15.6	--	--	--	--	--	--	--	--	--
Boron	25	--	--	--	--	--	--	--	--	--
Cadmium	41	--	--	--	--	--	--	--	--	--
Chromium, Total	410	--	--	--	--	--	--	--	--	--
Cobalt	13	--	--	--	--	--	--	--	--	--
Copper	51.9	--	--	--	--	--	--	--	--	--
Manganese	3460	--	--	--	--	--	--	--	--	--
Mercury	0.32	--	--	--	--	--	--	--	--	--
Molybdenum	29	--	--	--	--	--	--	--	--	--
Nickel	220	--	--	--	--	--	--	--	--	--
Selenium	29	**13.6 J-,B**	**12.6 J-,B**	**2.3 J-,B**	**0.8 J-,B**	<0.5 UJ	<0.5 UJ	<0.5 UJ	**0.7 J-,B**	<0.5
Silver	1.7	--	--	--	--	--	--	--	--	--
Thallium	1.1	--	--	--	--	--	--	--	--	--
Uranium	36	--	--	--	--	--	--	--	--	--
Vanadium	300	--	--	--	--	--	--	--	--	--
Zinc	1200	--	--	--	--	--	--	--	--	--
Chemistry Parameters										
Chromium, Hexavalent (mg/kg)	--	--	--	--	--	--	--	--	--	--
Total solids (Percent)	--	--	--	--	--	--	--	--	--	--

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

TABLE B-1a

SUMMARY OF UPLAND SOIL RESULTS - HENRY SITE
P4 RI/FS
(Page 14 of 20)

Location Identification		MWD086	MWD086	MWD086	MWD086	MWD086	MWD086	MWD086	MWD086
Field Sample Identification		SSMWD086-24-C(5)	SSMWD086-25-C(5)	SSMWD086-26-C(5)	0906-MWD086-01-SS	0906-MWD086-02-SS	0906-MWD086-03-SS	0906-MWD086-04-SS	0906-MWD086-05-SS
Date Collected		7/22/2004	7/22/2004	7/22/2004	6/16/2009	6/15/2009	6/15/2009	6/15/2009	6/15/2009
Analyte/Methods (Units)									
Metals (mg/kg)	**Background Limits mg/kg**								
Antimony	3.6	--	--	--	**4.6**	<0.351	**5.96**	**4.99**	**2.01 F**
Arsenic	15.6	--	--	--	**33.4**	**4.0**	**29**	**29**	**18.8**
Boron	25	--	--	--	<9.23	**2.27 F**	**20.6**	**23.9**	**27.4**
Cadmium	41	--	--	--	**37.5 J+**	**2.85**	**48.9**	**45.6**	**18.7**
Chromium, Total	410	--	--	--	**141**	**19.9 J+**	**456 J+**	**347 J+**	**243 J+**
Cobalt	13	--	--	--	**7.8**	**7.88**	**6.16**	**7.29**	**11**
Copper	51.9	--	--	--	**148**	**11.1**	**131**	**137**	**112**
Manganese	3460	--	--	--	**287**	**684**	**264**	**315**	**222**
Mercury	0.32	--	--	--	**0.457**	**0.0259 F**	**0.503**	**0.499**	**0.373**
Molybdenum	29	--	--	--	**12.9**	<1.05	**23**	**17.7**	**10.3 F**
Nickel	220	--	--	--	**109**	**22.5 J-**	**320 J-**	**265 J-**	**175 J-**
Selenium	29	<0.5	<0.5	<0.5	**46.4 J+**	**0.687 F**	**47.9**	**59.6**	**10.5**
Silver	1.7	--	--	--	**3.94**	**0.272**	**6.55**	**5.28**	**3.16**
Thallium	1.1	--	--	--	**1.23**	**0.273**	**1.07**	**1.49**	**0.639**
Uranium	36	--	--	--	**43.2 J+**	**2.91**	**45.4**	**43.7**	**27.4**
Vanadium	300	--	--	--	**97.6**	**27.3 J+**	**386 J+**	**265 J+**	**123 J+**
Zinc	1200	--	--	--	**973**	**121**	**1240**	**1030**	**536**
Chemistry Parameters									
Chromium, Hexavalent (mg/kg)	--	--	--	--	<0.496	<0.988	<0.5	<1.0	<0.987
Total solids (Percent)	--	**94.1**	**92**	**90.2**	--	--	--	--	--

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

TABLE B-1a

SUMMARY OF UPLAND SOIL RESULTS - HENRY SITE
P4 RI/FS

Analyte/Methods (Units)	Location Identification / Field Sample Identification / Date Collected	MWD086 0906-MWD086-06-SS 6/15/2009	MWD086 0906-MWD086-07-SS-1 6/17/2009	MWD086 Dup 0906-MWD086-07-SS-2 6/17/2009	MWD086 Triplicate 0906-MWD086-07-SS-3 6/17/2009	MWD086 Average 0906-MWD086-07-SS-avg 6/17/2009	MWD086 0906-MWD086-08-SS 6/15/2009	MWD086 0906-MWD086-09-SS 6/16/2009	MWD086 0906-MWD086-10-SS 6/16/2009
Metals (mg/kg)	**Background Limits mg/kg**								
Antimony	3.6	**0.685 F**	**1.96 F**	**1.12**	**0.998**	**1.3593 F**	<0.37	<0.357	**5.87**
Arsenic	15.6	**13**	**12.3**	**13.8**	**12.3**	**12.8**	**4.5**	**6.05**	**24.6**
Boron	25	**4.56**	**26.6**	**2.42 F**	**1.78 F**	**10.267 F**	**2.86 F**	**2.24 F**	<9.34
Cadmium	41	**3.79**	**7.58**	**5.34**	**5.52**	**6.147**	**2.13**	**2.24 J+**	**28.5 J+**
Chromium, Total	410	**81.6 J+**	**166 J**	**91 J**	**90.3 J**	**115.77 J**	**22.7 J+**	**31.4**	**183**
Cobalt	13	**7.12**	**5.7**	**5.91**	**6.51**	**6.04**	**9.86**	**11.8**	**9.9**
Copper	51.9	**59.9**	**69.4**	**66.4**	**66.5**	**67.43**	**18.9**	**28.9**	**115**
Manganese	3460	**402**	**428**	**398**	**396**	**407.3**	**1230**	**2040**	**510**
Mercury	0.32	**0.258**	**0.207 F**	**0.191 F**	**0.2 F**	**0.1993 F**	**0.0221 F**	**0.0257 F**	**0.25**
Molybdenum	29	**5.27**	**7.9 F,J-**	**5.71 J-**	**5.95 J-**	**6.52 F,J-**	<1.11	<1.07	**17.1**
Nickel	220	**121 J-**	**135**	**121**	**133**	**129.7**	**26.2 J-**	**36.9**	**95.8**
Selenium	29	**9.44**	**11.3**	**9.43**	**9.77**	**10.167**	**2.86**	**4.51 J+**	**28.5 J+**
Silver	1.7	**0.415 F**	**0.769**	**0.504**	**0.538**	**0.6037**	**0.26**	<0.249	**3.66**
Thallium	1.1	**0.433**	**0.648**	**0.539**	**0.559**	**0.582**	**0.261**	**0.171**	**1.66**
Uranium	36	**12.7**	**17**	**14.9**	**16.2**	**16.03**	**1.64**	**2.01 J+**	**48.7 J+**
Vanadium	300	**39.7 J+**	**75.4**	**57.9**	**57.8**	**63.7**	**22.3 J+**	**28.7**	**141**
Zinc	1200	**423**	**461 J**	**372 J**	**375 J**	**402.7 J**	**135**	**173**	**878**
Chemistry Parameters									
Chromium, Hexavalent (mg/kg)	--	<0.998	<0.499	<0.491	<0.25	<0.499	<0.995	<0.246	<0.249
Total solids (Percent)	--	--	--	--	--	--	--	--	--

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

TABLE B-1a

SUMMARY OF UPLAND SOIL RESULTS - HENRY SITE
P4 RI/FS

Location Identification		MWD087	MWD087	MWD087	MWD087	MWD087	MWD087	MWD087	MWD087 Dup
Field Sample Identification		0906-MWD087-01-SS	0906-MWD087-02-SS	0906-MWD087-03-SS	0906-MWD087-04-SS	0906-MWD087-05-SS	0906-MWD087-06-SS	0906-MWD087-07-SS-1	0906-MWD087-07-SS-2
Date Collected		6/15/2009	6/15/2009	6/15/2009	6/15/2009	6/16/2009	6/16/2009	6/16/2009	6/16/2009
Analyte/Methods (Units)									
Metals (mg/kg)	**Background Limits mg/kg**								
Antimony	3.6	**3.92**	**4.94**	**3.29 F**	**5.63**	**5.13**	**4.34**	**4.93**	**4.08**
Arsenic	15.6	**25.8**	**27**	**16**	**32.1**	**21.8**	**28.6**	**29.6**	**30.8**
Boron	25	**22.4**	**19.5**	**27.3**	**14.7 F**	**17.7 F**	<9.34	**17.7 F**	<9.16
Cadmium	41	**25.5**	**30.9**	**47.5**	**35.5**	**27 J+**	**41.5 J+**	**39.1 J+**	**41.3 J+**
Chromium, Total	410	**215 J+**	**363 J+**	**286 J+**	**375 J+**	**268**	**219**	**255**	**202**
Cobalt	13	**7.07**	**6.04**	**2.98**	**7.14**	**4.56**	**7.53**	**7.0**	**9.65**
Copper	51.9	**93.9**	**128**	**143**	**108**	**127**	**115**	**124**	**139**
Manganese	3460	**497**	**179**	**68.8**	**408**	**136**	**292**	**313**	**376**
Mercury	0.32	**0.451**	**0.411**	**0.451**	**0.433**	**0.366**	**0.34**	**0.378**	**0.371**
Molybdenum	29	**22.4**	**24**	**7.08 F**	**28.9**	**20.9**	**20.1**	**24**	**25.7**
Nickel	220	**267 J-**	**268 J-**	**166 J-**	**300 J-**	**234**	**250**	**257**	**246**
Selenium	29	**19.7**	**96.2**	**12**	**31.4**	**32.5 J+**	**24.8 J+**	**37.2 J+**	**36.1 J+**
Silver	1.7	**3.28**	**4.76**	**5.73**	**3.42**	**4.75**	**3.29**	**3.16**	**3.57**
Thallium	1.1	**1.31**	**0.972**	**1.63**	**2.31**	**0.957**	**1.35**	**1.3**	**1.46**
Uranium	36	**23.6**	**33.5**	**40.3**	**37.1**	**34.5 J+**	**36.2 J+**	**35.8 J+**	**36.9 J+**
Vanadium	300	**168 J+**	**182 J+**	**230 J+**	**273 J+**	**167**	**258**	**284**	**214**
Zinc	1200	**889**	**1150**	**843**	**1290**	**825**	**1430**	**1350**	**1340**
Chemistry Parameters									
Chromium, Hexavalent (mg/kg)	--	<0.998	<0.5	<1.0	<0.999	<0.5	<0.498	<0.498	<0.25
Total solids (Percent)	--	--	--	--	--	--	--	--	--

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

TABLE B-1a

SUMMARY OF UPLAND SOIL RESULTS - HENRY SITE
P4 RI/FS

Location Identification		MWD087 Triplicate	MWD087 Average	MWD087	MWD087	MWD087	MWD088	MWD088 Dup	MWD088 Triplicate
Field Sample Identification		0906-MWD087-07-SS-3	0906-MWD087-07-SS-avg	0906-MWD087-08-SS	0906-MWD087-09-SS	0906-MWD087-10-SS	0906-MWD088-01-SS-1	0906-MWD088-01-SS-2	0906-MWD088-01-SS-3
Date Collected		6/16/2009	6/16/2009	6/16/2009	6/16/2009	6/16/2009	6/15/2009	6/15/2009	6/15/2009
Analyte/Methods (Units)	Background Limits mg/kg								
Metals (mg/kg)									
Antimony	3.6	**4.92**	**4.643**	**3.68 F**	**7.55**	**4.84**	**5.27**	**4.13**	**4.0**
Arsenic	15.6	**30.4**	**30.27**	**21.9**	**30.1**	**22.9**	**27.7**	**25.2**	**25.6**
Boron	25	**16.5 F**	**17.1 F**	<9.38	**17.6 F**	<9.33	**9.96 F**	<8.72	**13.5 F**
Cadmium	41	**36.8 J+**	**39.07 J+**	**24.8 J+**	**35.8 J+**	**28 J+**	**23.7**	**25.7**	**24.1**
Chromium, Total	410	**187**	**214.7**	**248**	**383**	**252**	**284 J+**	**385 J+**	**304 J+**
Cobalt	13	**10.4**	**9.017**	**6.2**	**6.12**	**5.28**	**6.33**	**6.7**	**7.63**
Copper	51.9	**126**	**129.7**	**101**	**172**	**143**	**124**	**125**	**127**
Manganese	3460	**350**	**346.3**	**289**	**280**	**165**	**198**	**203**	**213**
Mercury	0.32	**0.344**	**0.3643**	**0.288**	**0.43**	**0.36**	**0.418**	**0.447**	**0.437**
Molybdenum	29	**24.8**	**24.83**	**35.7**	**33.4**	**22.8**	**22.7**	**22**	**26**
Nickel	220	**239**	**247.3**	**298**	**350**	**225**	**239 J-**	**230 J-**	**252 J-**
Selenium	29	**30.6 J+**	**34.63 J+**	**25 J+**	**49.1 J+**	**29.6 J+**	**39.1**	**26.6**	**32.7**
Silver	1.7	**3.37**	**3.367**	**2.56**	**4.72**	**4.19**	**3.3**	**3.74**	**3.73**
Thallium	1.1	**1.34**	**1.367**	**0.917**	**0.985**	**0.828**	**0.902**	**1.02**	**0.869**
Uranium	36	**33.5 J+**	**35.4 J+**	**25 J+**	**43 J+**	**40.3 J+**	**32**	**35.5**	**35.8**
Vanadium	300	**212**	**236.7**	**197**	**194**	**165**	**155 J+**	**154 J+**	**136 J+**
Zinc	1200	**1300**	**1330**	**1340**	**1190**	**893**	**934**	**887**	**965**
Chemistry Parameters									
Chromium, Hexavalent (mg/kg)	--	<0.491	<0.498	<0.5	<0.499	<0.499	<0.499	<0.999	<0.991
Total solids (Percent)	--	--	--	--	--	--	--	--	--

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

Analyte/Methods (Units)	Location Identification / Field Sample Identification / Date Collected	MWD088 Average 0906-MWD088-01-SS-avg 6/15/2009	MWD088 0906-MWD088-02-SS 6/23/2009	MWD088 0906-MWD088-03-SS 6/15/2009	MWD088 0906-MWD088-04-SS 6/16/2009	MWD088 0906-MWD088-AL01-SS 6/19/2009	MWD088 0906-MWD088-06-SS 6/15/2009	MWD088 0906-MWD088-07-SS 6/16/2009	MWD088 0906-MWD088-08-SS 6/16/2009
Metals (mg/kg)	**Background Limits mg/kg**								
Antimony	3.6	**4.467**	**4.54**	**4.18**	**6.07**	**8.18**	<0.357	**6.06**	**7.72**
Arsenic	15.6	**26.17**	**14.7**	**25.1**	**33 J+**	**34**	**7.92**	**30 J+**	**44.5 J+**
Boron	25	**11.73 F**	**11.3 F,J+**	**17.6 F**	**11.5 F**	**16.6 F,J-**	**3.97**	**11.8 F**	**21.7**
Cadmium	41	**24.5**	**39.3 J+**	**22.3**	**29.2 J+**	**33.1**	**6.33**	**58.2 J+**	**28.5 J+**
Chromium, Total	410	**324.3 J+**	**151**	**330 J+**	**330**	**339 J+**	**40.3 J+**	**501**	**485**
Cobalt	13	**6.887**	**5.73**	**11.1**	**7.23**	**6.18**	**10.2**	**7.11**	**7.24**
Copper	51.9	**125.3**	**67**	**95.1**	**108**	**135**	**35**	**122**	**134**
Manganese	3460	**204.7**	**296 J**	**710**	**202 J**	**189**	**1650**	**267 J**	**165 J**
Mercury	0.32	**0.434**	**0.278**	**0.452**	**0.446**	**0.484**	**0.0735 F**	**0.404**	**0.494**
Molybdenum	29	**23.57**	**7.96 F**	**7.67 F**	**21.2**	**23.6**	**1.41 F**	**22.2**	**28.4**
Nickel	220	**240.3 J-**	**136**	**236 J-**	**260**	**277**	**41.9 J-**	**265**	**345**
Selenium	29	**32.8**	**21.8**	**10.1**	**35.3 J+**	**31.8 J**	**2.62**	**55.4 J+**	**53.1 J+**
Silver	1.7	**3.59**	**2.42 J-**	**2.21**	**3.11**	**3.72**	**0.604**	**5.53**	**3.7**
Thallium	1.1	**0.9303**	**1.85**	**1.12**	**1.1**	**1.27**	**0.333**	**1.91**	**1.22**
Uranium	36	**34.43**	**32.9 J-**	**23.8**	**32.4**	**36.5**	**6.52**	**64**	**30.4**
Vanadium	300	**148.3 J+**	**158**	**149 J+**	**205**	**256 J+**	**38.7 J+**	**584**	**332**
Zinc	1200	**928.7**	**800**	**926**	**1010**	**787 J-,B**	**199**	**1210**	**1320**
Chemistry Parameters									
Chromium, Hexavalent (mg/kg)	--	<0.999	<0.496	<0.997	<0.497 UJ	<0.498	<0.496	<0.48 UJ	<0.249 UJ
Total solids (Percent)	--	--	--	--	--	--	--	--	--

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

TABLE B-1a

SUMMARY OF UPLAND SOIL RESULTS - HENRY SITE
P4 RI/FS

Location Identification / Field Sample Identification / Date Collected / Analyte/Methods (Units)	Background Limits mg/kg	MWD088 0906-MWD088-09-SS 6/23/2009	MWD088 0906-MWD088-10-SS 6/16/2009	MWD090 0906-MWD090-01-SS 6/16/2009	MWD090 0906-MWD090-02-SS 6/17/2009	MWD090 0906-MWD090-03-SS 6/16/2009	MWD090 0906-MWD090-04-SS 6/17/2009	MWD090 0906-MWD090-05-SS 6/16/2009	MWD090 0906-MWD090-06-SS 6/16/2009
Metals (mg/kg)									
Antimony	3.6	**1.86**	**3.06 F**	**0.743 F**	**1.77**	**2.42 F**	**8.85**	**5.62**	**6.64**
Arsenic	15.6	**17.9**	**22.3 J+**	**8.85**	**7.89**	**13.8**	**34.9**	**21**	**30.4**
Boron	25	**1.99 F,J+**	**18.8 F**	<1.88	**11.3**	<9.4	**28.1**	<9.09	**12.8 F**
Cadmium	41	**22.7 J+**	**25.1 J+**	**12.6 J+**	**19.1**	**35.7 J+**	**45.5**	**36.2 J+**	**36 J+**
Chromium, Total	410	**162**	**332**	**41.9**	**85.4 J**	**147**	**519 J**	**423**	**296**
Cobalt	13	**7.83**	**7.64**	**9.74**	**8.07**	**5.96**	**8.45**	**4.21**	**7.37**
Copper	51.9	**78.2**	**127**	**26.4**	**30.8**	**58.1**	**134**	**148**	**122**
Manganese	3460	**334 J**	**249 J**	**893**	**1870**	**413**	**266**	**123**	**269**
Mercury	0.32	**0.27**	**0.332**	**0.0664 F**	**0.116 F**	**0.193 F**	**0.414**	**0.451**	**0.42**
Molybdenum	29	**6.98 F**	**7.37 F**	**4.48**	**4.27 J-**	**9.06 F**	**19.9 J-**	**18.2**	**23.8**
Nickel	220	**109**	**168**	**88.9**	**95.8**	**178**	**425**	**240**	**256**
Selenium	29	**16.1**	**13.7 J+**	**8.45 J+**	**8.64**	**34.4 J+**	**318**	**36.8 J+**	**41.2 J+**
Silver	1.7	**2.13 J-**	**2.93**	**0.733 F**	**1.76**	**2.39**	**7.07**	**4.51**	**3.43**
Thallium	1.1	**1.07**	**1.0**	**1.18**	**0.983**	**1.42**	**1.51**	**1.24**	**1.59**
Uranium	36	**28.4 J-**	**40.6**	**8.55 J+**	**18.9**	**32.3 J+**	**44.9**	**41.7 J+**	**36.9 J+**
Vanadium	300	**147**	**180**	**81.8**	**117**	**143**	**412**	**255**	**227**
Zinc	1200	**432**	**640**	**461**	**403 J**	**880**	**1610 J**	**882**	**1220**
Chemistry Parameters									
Chromium, Hexavalent (mg/kg)	--	<0.249	<0.246 UJ	<0.494	<0.486	<0.245	<0.249	<0.494	<0.486
Total solids (Percent)	--	--	--	--	--	--	--	--	--

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

TABLE B-1a

SUMMARY OF UPLAND SOIL RESULTS - HENRY SITE
P4 RI/FS
(Page 20 of 20)

Location Identification		MWD090	MWD090 Dup	MWD090 Triplicate	MWD090 Average	MWD090	MWD090	MWD090
Field Sample Identification		0906-MWD090-07-SS1	0906-MWD090-07-SS2	0906-MWD090-07-SS3	0906-MWD090-07-SS-avg	0906-MWD090-08-SS	0906-MWD090-09-SS	0906-MWD090-10-SS
Date Collected		6/16/2009	6/16/2009	6/16/2009	6/16/2009	6/16/2009	6/16/2009	6/16/2009
Analyte/Methods (Units)								
Metals (mg/kg)	**Background Limits mg/kg**							
Antimony	3.6	**4.96**	**5.12**	**5.22**	**5.1**	**5.87**	**5.2**	**4.63**
Arsenic	15.6	**24.1**	**21.5**	**25.6 J+**	**23.7 J+**	**29.3 J+**	**23.7 J+**	**25.8 J+**
Boron	25	<8.37	<9.36	**13.9 F**	**13.9 J**	**13.8 F**	**15.1 F**	**17.3 F**
Cadmium	41	**28.8 J+**	**27 J+**	**30.9 J+**	**28.9 J+**	**21.6 J+**	**33.2 J+**	**38.3 J+**
Chromium, Total	410	**235**	**223**	**392**	**283**	**458**	**400**	**384**
Cobalt	13	**11.3**	**6.85**	**5.56**	**7.9**	**6.01**	**6.19**	**7.22**
Copper	51.9	**110**	**111**	**113**	**111**	**138**	**134**	**124**
Manganese	3460	**318**	**283**	**292 J**	**298 J**	**182 J**	**646 J**	**225 J**
Mercury	0.32	**0.381**	**0.349**	**0.374**	**0.368**	**0.453**	**0.429**	**0.436**
Molybdenum	29	**19.3**	**16.9**	**19.4**	**18.5**	**18.7**	**13.3**	**22.2**
Nickel	220	**196**	**162**	**266**	**208**	**328**	**274**	**300**
Selenium	29	**29.2 J+**	**28.5 J+**	**35.2 J+**	**31 J+**	**146 J+**	**62.4 J+**	**95.6 J+**
Silver	1.7	**3.46**	**3.29**	**3.53**	**3.43**	**6.58**	**7.3**	**6.11**
Thallium	1.1	**1.41**	**1.13**	**1.47**	**1.34**	**0.736**	**1.18**	**1.06**
Uranium	36	**35.2 J+**	**32.8 J+**	**33.7**	**33.9 J+**	**33.7**	**47.4**	**36.1**
Vanadium	300	**144**	**184**	**213**	**180**	**205**	**322**	**271**
Zinc	1200	**934**	**817**	**942**	**898**	**1130**	**1050**	**985**
Chemistry Parameters								
Chromium, Hexavalent (mg/kg)	--	<0.5	<0.491	<0.247 UJ	<0.5	<0.247 UJ	<0.495 UJ	<0.491 UJ
Total solids (Percent)	--	--	--	--	--	--	--	--

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

TABLE B-1b

SUMMARY OF UPLAND SOIL RADIOLOGICAL RESULTS - HENRY SITE
P4 RI/FS
(Page 1 of 4)

Analyte/Methods (Units)	Location Identification Field Sample Identification Date Collected	H1 1410-H1 10/9/2014	H2 1410-H2 10/9/2014	H3 1410-H3 10/9/2014	H3 Dup 1410-H3 10/9/2014	H3 Avg 1410-H3 10/9/2014	H4 1410-H4 10/9/2014
Metals	**Background Limits mg/kg**						
Uranium (mg/kg)	36	--	--	--	--	--	--
Radionuclides							
Potassium-40 (pCi/g)	--	--	--	--	--	--	--
Radium-226 (pCi/g)	15.1	--	--	--	--	--	--
Radon-222 (pCi/m^2-s)	--	**3.55**	**9.1**	**1.58**	**3.17**	**2.375**	**4.83**
Thorium-232 (pCi/g)	--	--	--	--	--	--	--

mg/kg milligrams per kilogram.
pCi/g picoCuries/gram
pCi/m^2-s picoCuries per square meter second
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
D Sample dilution required for analysis; reported values reflect the dilution.
J+ Data are estimated due to associated quality control data; potential high bias.

TABLE B-1b

SUMMARY OF UPLAND SOIL RADIOLOGICAL RESULTS - HENRY SITE
P4 RI/FS

Location Identification Field Sample Identification Date Collected Analyte/Methods (Units)		H5 1410-H5 10/9/2014	H6 1410-H6 10/9/2014	H7 1410-H7 10/9/2014	H8 1410-H8 10/9/2014	H9 1410-H9 10/9/2014	H10 1410-H10 10/9/2014
Metals	**Background Limits mg/kg**						
Uranium (mg/kg)	36	--	--	--	--	--	--
Radionuclides							
Potassium-40 (pCi/g)	--	--	--	--	--	--	--
Radium-226 (pCi/g)	15.1	--	--	--	--	--	--
Radon-222 (pCi/m^2-s)	--	**2.73**	**5.58**	**3.44**	**6.73**	**3.97**	**2.01**
Thorium-232 (pCi/g)	--	--	--	--	--	--	--

mg/kg milligrams per kilogram.
pCi/g picoCuries/gram
pCi/m^2-s picoCuries per square meter second
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
D Sample dilution required for analysis; reported values reflect the dilution.
J+ Data are estimated due to associated quality control data; potential high bias.

TABLE B-1b

SUMMARY OF UPLAND SOIL RADIOLOGICAL RESULTS - HENRY SITE
P4 RI/FS

Location Identification		H11	H11 Dup	H11 Avg	H12	H13	H14
Field Sample Identification		1410-H11	1410-H11	1410-H11	1410-H12	1410-H13	1410-H14
Date Collected		10/9/2014	10/9/2014	10/9/2014	10/9/2014	10/9/2014	10/9/2014
Analyte/Methods (Units)							
Metals	**Background Limits mg/kg**						
Uranium (mg/kg)	36	--	--	--	--	--	--
Radionuclides							
Potassium-40 (pCi/g)	--	--	--	--	--	--	--
Radium-226 (pCi/g)	15.1	--	--	--	--	--	--
Radon-222 (pCi/m^2-s)	--	**1.35**	**2.79**	**2.07**	**3.41**	**3.28**	**7.74**
Thorium-232 (pCi/g)	--	--	--	--	--	--	--

mg/kg milligrams per kilogram.
pCi/g picoCuries/gram
pCi/m^2-s picoCuries per square meter second
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
D Sample dilution required for analysis; reported values reflect the dilution.
J+ Data are estimated due to associated quality control data; potential high bias.

TABLE B-1b

SUMMARY OF UPLAND SOIL RADIOLOGICAL RESULTS - HENRY SITE
P4 RI/FS
(Page 4 of 4)

	Location Identification	**H15**	**MOS-04**	**MOS-05**	**MOS-06**
	Field Sample Identification	**1410-H15**	**1410-MOS-04-SS**	**1410-MOS-05-SS**	**1410-MOS-06-SS**
	Date Collected	**10/9/2014**	**10/7/2014**	**10/7/2014**	**10/7/2014**
Analyte/Methods (Units)					
	Background Limits mg/kg				
Metals					
Uranium (mg/kg)	36	--	**31 D**	**57 D**	**2.0 D**
Radionuclides					
Potassium-40 (pCi/g)	--	--	**15.1 J+**	**14.2 J+**	**14.4 J+**
Radium-226 (pCi/g)	15.1	--	**16.1 J+**	**23.7 J+**	**1.98 J+**
Radon-222 (pCi/m^2-s)	--	**3.34**	--	--	--
Thorium-232 (pCi/g)	--	--	<1	<1	**1.24 J+**

mg/kg milligrams per kilogram.
pCi/g picoCuries/gram
pCi/m^2-s picoCuries per square meter second
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
D Sample dilution required for analysis; reported values reflect the dilution.
J+ Data are estimated due to associated quality control data; potential high bias.

TABLE B-2

SUMMARY OF UPLAND VEGETATION RESULTS
P4 RI/FS

Location Identification		MBH002-01	MBH002-01	MBH002-01	MBH002-02	MBH002-02	MBH002-02	MBH002-03
Field Sample Identification		0906-MBH002-01-GF	0906-MBH002-01-SL-ARTR	0906-MBH002-01-SM-ARTR	0906-MBH002-02-GF	0906-MBH002-02-SL-ARTR	0906-MBH002-02-SM-ARTR	0906-MBH002-03-GF
Date Collected		6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009
Analyte/Methods (Units)								
Metals (mg/kg)	**Background Limits mg/kg**							
Antimony	5.41	<0.495	<0.475	<0.464	<0.493	<0.493	<0.487	<0.479
Arsenic	--	**0.091 F,J-**	**0.199 F,J-**	**0.185 F,J-**	**0.09 F**	**0.0827 F**	<0.0712	**0.225 F,J-**
Boron	61.7	**9.94**	**39.8**	**14.9**	**7.78**	**42.6**	**10.7**	**6.18**
Cadmium	1.7	**0.108**	**0.142**	**0.265**	**0.0849 F**	**0.177**	**0.127**	**0.231**
Chromium, Total	--	**1.9**	**1.97**	**4.12**	**3.39 J**	**3.09 J**	**2.48 J**	**3.45**
Cobalt	--	<0.125	<0.124	<0.121	<0.12	<0.117	<0.119	<0.116
Copper	--	**5.2**	**13.1**	**9.23**	**4.34**	**19.4**	**5.66**	**4.85**
Manganese	--	**76.5**	**144**	**57**	**73.6**	**144**	**67.7**	**75.6**
Mercury	0.0526	<0.00998	<0.00994	<0.00967	<0.00962	<0.00935	<0.00949	<0.00928
Molybdenum	5.78	<1.49	<1.43	<1.39	**2.63 F**	<1.48	<1.46	**1.84 F**
Nickel	--	**1.11**	**1.25**	**1.92**	**0.639 F**	**1.04**	**0.42 F**	**1.56**
Selenium	3.41	**0.383 J+**	**0.722**	**0.581**	**0.456 J+**	**0.318 J+**	**0.123 F,J-,B**	**0.941**
Silver	0.27	<0.0499	<0.0497	<0.0484	<0.0481	<0.0467	<0.0474	<0.0464
Thallium	0.0163	<0.00998	<0.00994	<0.00967	<0.00962	<0.00935	<0.00949	<0.00928
Uranium, Total	0.162	<0.0998	<0.0994	**0.162 F**	<0.0962	<0.0935	<0.0949	<0.0928
Vanadium	--	**0.513**	**0.631**	**1.05**	**0.945**	**0.84**	**0.703**	**0.988**
Zinc	--	**24.3**	**31.8**	**17.9**	**23.1**	**65**	**17**	**30.6**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

TABLE B-2

SUMMARY OF UPLAND VEGETATION RESULTS
P4 RI/FS

Location Identification		MBH002-03	MBH002-03	MBH002-03	MBH002-03	MBH002-04	MBH002-05	MBH002-05
Field Sample Identification		0906-MBH002-03-SL-AMAL	0906-MBH002-03-SM-AMAL	0906-MBH002-03-SL-ARTR	0906-MBH002-03-SM-ARTR	0906-MBH002-04-GF	0906-MBH002-05-FB	0908-MBH002-05-FB
Date Collected		6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009	8/25/2009
Analyte/Methods (Units)								
Metals (mg/kg)	**Background Limits mg/kg**							
Antimony	5.41	<0.487	<0.497	<0.486	<0.48	<0.48	<0.495	<0.489
Arsenic	--	**5.87 J-**	<0.0735	**0.142 F,J-**	<0.0718 UJ	**0.314 J-**	**0.914 J**	**0.516 J**
Boron	61.7	**12.5**	**9.6**	**47.8**	**28.4**	**12.4**	**29.5**	**41.8**
Cadmium	1.7	**0.0248 F**	**0.0872 F**	**0.106**	**0.202**	**0.117**	**0.277**	**0.082 J**
Chromium, Total	--	**2.15**	**3.0 J**	**2.23**	**1.66**	**2.58**	**7.36**	**1.83 J**
Cobalt	--	<0.121	<0.123	<0.116	<0.12	**0.145 F**	**1.29**	<0.614
Copper	--	**3.67**	**3.55**	**7.24**	**5.91**	**6.23**	**9.68**	**6.81**
Manganese	--	**25.6**	**322**	**80.5**	**142**	**91**	**261**	**84.3**
Mercury	0.0526	<0.00971	**0.0135 F**	**0.00946 F,B**	<0.00958	<0.00973	<0.0094	<0.0196
Molybdenum	5.78	<1.46	<1.49	<1.46	<1.44	**1.77 F**	<1.48	<1.47
Nickel	--	**1.18**	**0.48 F**	**0.799**	**0.485 F**	**3.49**	**4.71**	<0.982
Selenium	3.41	**0.575**	**0.324 J+**	**0.594**	**0.239 J+**	**1.12**	**0.518**	**1.63**
Silver	0.27	<0.0485	<0.049	<0.0464	<0.0479	<0.0486	**0.0705 F**	<0.0491
Thallium	0.0163	<0.00971	<0.0098	<0.00928	<0.00958	<0.00973	**0.0145 F**	<0.00982
Uranium, Total	0.162	<0.0971	<0.098	<0.0928	<0.0958	<0.0973	<0.094	<0.0982
Vanadium	--	**0.558**	**0.849**	**0.71**	**0.445 F**	**0.867**	**3.67**	<0.614
Zinc	--	**12.1**	**14.7**	**14.3**	**16.3**	**24.6**	**25.1**	**16.4**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

Location Identification		MBH002-05	MBH002-05	MBH002-05	MBH002-05	MBH002-05	MBH002-05	MBH002-05
Field Sample Identification		0906-MBH002-05-GS	0906-MBH002-05-SL-ARTR	0906-MBH002-05-SM-ARTR	0906-MBH002-05-SL-PUTR	0906-MBH002-05-SM-PUTR	0906-MBH002-05-SL-SYAL	0906-MBH002-05-SM-SYAL
Date Collected		6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009
Analyte/Methods (Units)								
Metals (mg/kg)	**Background Limits mg/kg**							
Antimony	5.41	<0.498	<0.496	<0.967	<0.496	<0.496	<0.497	<0.495
Arsenic	--	<0.0713 UJ	**0.0781 F,J**	<0.0708 UJ	<0.0717 UJ	<0.0704 UJ	<0.0735 UJ	<0.0746 UJ
Boron	61.7	**3.66 F**	**29.2**	**26**	**30.1**	**10.4**	**36.3**	**9.04**
Cadmium	1.7	<0.0238	**0.145**	**0.211**	**0.0284 F**	**0.0696 F**	<0.0245	**0.0697 F**
Chromium, Total	--	**3.07**	**2.77**	**2.23**	**1.86**	**2.64**	**2.44**	**3.86**
Cobalt	--	<0.119	<0.121	<0.118	<0.12	<0.117	<0.123	**0.125 F**
Copper	--	**7.19**	**15.7**	**13.6**	**4.88**	**4.65**	**5.17**	**4.2**
Manganese	--	**35.1**	**75.8**	**24.3**	**29.4**	**12.2**	**84.8**	**293**
Mercury	0.0526	<0.00951	**0.0109 F**	<0.00943	<0.00956	<0.00938	<0.0098	<0.00994
Molybdenum	5.78	**1.89 F**	<1.49	<2.9	<1.49	<1.49	<1.49	<1.48
Nickel	--	**0.665 F**	**1.01**	**0.676 F**	**2.23**	**1.46**	**1.16**	**1.39**
Selenium	3.41	**0.265 J+**	**0.34**	**0.145 F,B**	**0.169 F,B**	**0.153 F,B**	**0.216 B**	**0.11 F,B**
Silver	0.27	**0.598**	**0.122 F**	<0.0472	**0.0928 F**	**0.0505 F**	<0.049	**0.134 F**
Thallium	0.0163	<0.00951	<0.00965	<0.00943	<0.00956	<0.00938	<0.0098	<0.00994
Uranium, Total	0.162	<0.0951	<0.0965	<0.0943	<0.0956	<0.0938	<0.098	<0.0994
Vanadium	--	**0.383 F**	**0.577**	**0.402 F**	**0.495**	**0.555**	**0.392 F**	**0.576**
Zinc	--	**19.7**	**24.2**	**19.1**	**18**	**9.74**	**16.6**	**16.7**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

TABLE B-2

SUMMARY OF UPLAND VEGETATION RESULTS
P4 RI/FS

Location Identification		MBH002-06	MBH002-06	MBH002-06	MBH002-07	MBH002-07 Dup	MBH002-07 Triplicate	MBH002-07 Average
Field Sample Identification		0906-MBH002-06-GF	0906-MBH002-06-SL-SYAL	0906-MBH002-06-SM-SYAL	0906-MBH002-07-GF-1	0906-MBH002-07-GF-2	0906-MBH002-07-GF-3	0906-MBH002-07-GF-avg
Date Collected		6/17/2009	6/17/2009	6/17/2009	6/16/2009	6/16/2009	6/16/2009	6/16/2009
Analyte/Methods (Units)								
Metals (mg/kg)	**Background Limits mg/kg**							
Antimony	5.41	<0.481	<0.481	<0.498	<0.479	<0.499	<0.488	<0.499
Arsenic	--	**0.21 F,B**	<0.0676	<0.0741	**0.131 F**	**0.074 F**	**0.149 F**	**0.118 J**
Boron	61.7	**16.7**	**20.8**	**9.68**	**9.48**	**9.92**	**11**	**10.1**
Cadmium	1.7	**0.483**	<0.0225	**0.0681 F**	**0.171**	**0.0454 F,J**	**0.115**	**0.11 J**
Chromium, Total	--	**4.75**	**2.5**	**2.57**	**2.38**	**3.64**	**2.32**	**2.78**
Cobalt	--	**0.367 F**	<0.113	<0.124	<0.116	<0.116	<0.122	<0.122
Copper	--	**5.46**	**4.06**	**6.04**	**4.72**	**5.09**	**5.4**	**5.07**
Manganese	--	**130**	**183**	**366**	**49.9**	**47.6**	**51.1**	**49.5**
Mercury	0.0526	<0.00988 UJ	<0.00901 UJ	<0.00988 UJ	<0.0149	<0.0186 UJ	<0.0156	<0.0186
Molybdenum	5.78	**2.01 F**	**1.54 F**	<1.49	<1.44	**2.25 F**	<1.46	**2.25 J**
Nickel	--	**2.0**	**1.16**	**0.819**	**1.08**	**0.569 F**	**1.13**	**0.926 J**
Selenium	3.41	**0.296 J+**	**0.209 J+**	**0.108 F,J+,B**	**0.373**	**0.318**	**0.287**	**0.326**
Silver	0.27	<0.0494	<0.045	<0.0494	<0.0465	<0.0466 UJ	<0.0486	<0.0486
Thallium	0.0163	<0.00988	<0.00901	<0.00988	<0.00929	<0.00931	<0.00973	<0.00973
Uranium, Total	0.162	<0.0988	<0.0901	<0.0988	<0.0929	<0.0931	<0.0973	<0.0973
Vanadium	--	**1.58**	**0.676**	**0.664**	**0.432 F**	**0.947**	**0.576**	**0.652 J**
Zinc	--	**22.8 J-**	**17.3 J-**	**33.9 J-**	**20.5**	**19.9**	**16.1**	**18.8**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

Location Identification		MBH002-07	MBH002-07 Dup	MBH002-07 Average	MBH002-07	MBH002-07 Dup	MBH002-07 Average
Field Sample Identification		0906-MBH002-07-SL-1-ARTR	0906-MBH002-07-SL-2-ARTR	0906-MBH002-07-SL-avg-ARTR	0906-MBH002-07-SM-1-ARTR	0906-MBH002-07-SM-2-ARTR	0906-MBH002-07-SM-avg-ARTR
Date Collected		6/16/2009	6/16/2009	6/16/2009	6/16/2009	6/16/2009	6/16/2009
Analyte/Methods (Units)							
Metals (mg/kg)	**Background Limits mg/kg**						
Antimony	5.41	<0.484	<0.498	<0.498	<0.493	<0.489	<0.493
Arsenic	--	**0.188 F**	**0.0834 F**	**0.136 J**	**0.0884 F**	**0.0782 F**	**0.0833 J**
Boron	61.7	**25.2**	**27.6**	**26.4**	**10.1**	**19.9**	**15**
Cadmium	1.7	**0.0902 F**	**0.0801 F**	**0.0852 J**	**0.189**	**0.127**	**0.158**
Chromium, Total	--	**1.93**	**1.31**	**1.62**	**2.06**	**1.63**	**1.85**
Cobalt	--	<0.114	<0.117	<0.117	<0.116	<0.122	<0.122
Copper	--	**9.35**	**12.6**	**11**	**8.84**	**11.5**	**10.2**
Manganese	--	**84.5**	**84.8**	**84.7**	**47.9**	**29.7**	**38.8**
Mercury	0.0526	**0.0209 F**	<0.015	**0.0209 J**	<0.0149	<0.0157	<0.0157
Molybdenum	5.78	<1.45	<1.49	<1.49	**2.23 F**	<1.47	**2.23 J**
Nickel	--	**0.727 F**	**0.813**	**0.77 J**	**0.726 F**	**0.528 F**	**0.627 J**
Selenium	3.41	**0.689**	**0.467**	**0.578**	**0.234**	**0.2**	**0.217**
Silver	0.27	<0.0457	<0.0468	<0.0468	<0.0466	**0.0925 F**	**0.0925 J**
Thallium	0.0163	<0.00914	<0.00936	<0.00936	<0.00931	<0.00978	<0.00978
Uranium, Total	0.162	<0.0914	<0.0936	<0.0936	<0.0931	<0.0978	<0.0978
Vanadium	--	**0.553**	**0.419 F**	**0.486 J**	**0.495**	**0.387 F**	**0.441 J**
Zinc	--	**18.5**	**19.9**	**19.2**	**19.7**	**18.2**	**19**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

Location Identification		MBH002-07 Dup	MBH002-07 Triplicate	MBH002-07 Average	MBH002-07	MBH002-07	MBH002-07 Dup
Field Sample Identification		0906-MBH002-07-SL-2-SYAL	0906-MBH002-07-SL-3-SYAL	0906-MBH002-07-SL-avg-SYAL	0906-MBH002-07-SL-1-PUTR	0906-MBH002-07-SM-1-PUTR	0906-MBH002-07-SM-2-SYAL
Date Collected		6/16/2009	6/16/2009	6/16/2009	6/16/2009	6/16/2009	6/16/2009
Analyte/Methods (Units)							
	Background Limits mg/kg						
Metals (mg/kg)							
Antimony	5.41	<0.492	<0.5	<0.5	<0.497	<0.489	<0.977
Arsenic	--	<0.0737	<0.0735 UJ	<0.0737	<0.0721	<0.0709	<0.0653
Boron	61.7	**34**	**31.5**	**32.8**	**9.49**	**9.11**	**10.3 F**
Cadmium	1.7	<0.0246	**0.0262 F**	**0.0262 J**	**0.0599 F**	**0.0619 F**	**0.0868 F,J**
Chromium, Total	--	**1.15**	**1.28**	**1.22**	**1.53**	**0.959**	**3.23**
Cobalt	--	<0.123	<0.123	<0.123	<0.12	<0.118	<0.109
Copper	--	**4.16**	**4.73**	**4.45**	**3.28**	**2.05**	**4.54**
Manganese	--	**253**	**151**	**202**	**10.2**	**9.95**	**189**
Mercury	0.0526	<0.0157	<0.0157	<0.0157	<0.0154	<0.0151	<0.0174 UJ
Molybdenum	5.78	<1.48	**2.32 F**	**2.32 J**	<1.49	<1.47	<2.93
Nickel	--	**1.06**	**0.925**	**0.993**	**1.47**	**0.533 F**	**0.961**
Selenium	3.41	**0.199**	**0.551**	**0.375**	**0.237**	**0.109 F**	<0.0871
Silver	0.27	<0.0491	<0.049	<0.0491	<0.0481	<0.0473	<0.0436 UJ
Thallium	0.0163	<0.00982	<0.0098	<0.00982	<0.00962	<0.00945	<0.00871
Uranium, Total	0.162	<0.0982	<0.098	<0.0982	<0.0962	<0.0945	<0.0871
Vanadium	--	**0.275 F**	**0.335 F**	**0.305 J**	**0.467 F**	**0.273 F**	**0.918**
Zinc	--	**17**	**20**	**18.5**	**4.8**	**4.66**	**17.6**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

TABLE B-2

SUMMARY OF UPLAND VEGETATION RESULTS
P4 RI/FS
(Page 7 of 36)

Location Identification		MBH002-07 Triplicate	MBH002-07 Average	MBH002-08	MBH002-08	MBH002-08	MBH002-08
Field Sample Identification		0906-MBH002-07-SM-3-SYAL	0906-MBH002-07-SM-avg-SYAL	0906-MBH002-08-FB	0908-MBH002-08-FB	0906-MBH002-08-GS	0906-MBH002-08-SL-ARTR
Date Collected		6/16/2009	6/16/2009	6/18/2009	8/25/2009	6/18/2009	6/18/2009
Analyte/Methods (Units)							
Metals (mg/kg)	**Background Limits mg/kg**						
Antimony	5.41	<0.498	<0.977	<0.496	<0.491	<0.499	<0.969
Arsenic	--	<0.0713	<0.0713	**0.193 F,J-**	**0.198 J**	**6.67 J-**	**0.153 F,J-**
Boron	61.7	**10.3**	**10.3 J**	**19.8**	**22.8**	**3.7 F**	**34.3**
Cadmium	1.7	**0.0427 F**	**0.0648 J**	**0.23**	**0.0937 J**	**0.0289 F**	**0.0584 F**
Chromium, Total	--	**1.03**	**2.13**	**2.32**	**1.28**	**2.17**	**2.55**
Cobalt	--	<0.119	<0.119	**0.223 F**	<0.124	<0.123	<0.123
Copper	--	**6.89**	**5.72**	**5.87**	**4.53**	**4.9**	**7.05**
Manganese	--	**159**	**174**	**96.1**	**59**	**63.9**	**74.7**
Mercury	0.0526	<0.0152	<0.0174	<0.00929	<0.00992 UJ	<0.0098	<0.00982
Molybdenum	5.78	<1.49	<2.93	<1.49	<1.47	**2.54 F**	<2.91
Nickel	--	**0.645 F**	**0.803 J**	**1.58**	**0.602 J**	**0.57 F**	**0.798**
Selenium	3.41	**0.16 F**	**0.16 J**	**0.291 J+**	**0.832**	**0.362 J+**	**0.557**
Silver	0.27	<0.0475	<0.0475	**0.105 F**	<0.0496	**0.118 F**	<0.0491
Thallium	0.0163	<0.00951	<0.00951	<0.00929	<0.00992	<0.0098	<0.00982
Uranium, Total	0.162	<0.0951	<0.0951	<0.0929	<0.0992	<0.098	<0.0982
Vanadium	--	**0.204 F**	**0.561 J**	**0.893**	**0.376 J**	**0.432 F**	**0.816**
Zinc	--	**20.8**	**19.2**	**18.1**	**16.3 J-**	**20.5**	**9.78**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

TABLE B-2

SUMMARY OF UPLAND VEGETATION RESULTS
P4 RI/FS
(Page 8 of 36)

Location Identification		MBH002-08	MBH002-08	MBH002-08	MBH002-08	MBH002-08	MBH002-09
Field Sample Identification		0906-MBH002-08-SM-ARTR	0906-MBH002-08-SL-CHNA	0906-MBH002-08-SM-CHNA	0906-MBH002-08-SL-SYAL	0906-MBH002-08-SM-SYAL	0906-MBH002-09-GF
Date Collected		6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/16/2009
Analyte/Methods (Units)							
	Background Limits mg/kg						
Metals (mg/kg)							
Antimony	5.41	<1.55	<0.858	<1.0	<0.794	<0.839	<0.48
Arsenic	--	**0.079 F,J-**	**0.195 F,J-**	**0.266 F,J-**	<0.0698 UJ	<0.0716 UJ	**0.105 F**
Boron	61.7	**17.1**	**35.5**	**17.8**	**38**	**6.42 F**	**10.2**
Cadmium	1.7	**0.145**	**0.0606 F**	**0.171**	<0.0233	<0.0239	**0.134**
Chromium, Total	--	**1.83**	**2.67**	**2.59**	**1.83**	**1.56**	**2.31**
Cobalt	--	<0.12	<0.125	<0.133	**0.138 F**	<0.119	<0.116
Copper	--	**8.63**	**19.5**	**15**	**5.03**	**6.85**	**6.22**
Manganese	--	**33.4**	**84.8**	**55.5**	**180**	**120**	**71.6**
Mercury	0.0526	<0.00962	<0.00996	<0.0106	<0.00931	<0.00954	**0.0306 F**
Molybdenum	5.78	<4.66	<2.57	<3.0	<2.38	<2.52	**1.48 F**
Nickel	--	**0.694 F**	**0.869**	**0.754 F**	**2.14**	**0.678 F**	**0.887**
Selenium	3.41	**0.257 J+**	**0.812**	**1.2**	**0.319 J+**	0.0996 F,UB	**0.241**
Silver	0.27	<0.0481	<0.0498	<0.0532	**0.299**	**0.0996 F**	<0.0462
Thallium	0.0163	<0.00962	<0.00996	<0.0106	<0.00931	<0.00954	<0.00924
Uranium, Total	0.162	<0.0962	<0.0996	<0.106	<0.0931	<0.0954	<0.0924
Vanadium	--	**0.58**	**0.801**	**0.756**	**0.5**	**0.336 F**	**0.544**
Zinc	--	**10.1**	**38**	**24.1**	**12.6**	**6.73**	**24.1**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

TABLE B-2

SUMMARY OF UPLAND VEGETATION RESULTS
P4 RI/FS

Location Identification		MBH002-09	MBH002-09	MBH002-10	MBH002-10	MBH002-10	MBH002-10
Field Sample Identification		0906-MBH002-09-SL-PUTR	906-MBH002-09-SM-PUTI	0906-MBH002-10-FB	0908-MBH002-10-FB	0906-MBH002-10-GS	0906-MBH002-10-SL-AMAL
Date Collected		6/16/2009	6/16/2009	6/18/2009	8/25/2009	6/18/2009	6/18/2009
Analyte/Methods (Units)							
Metals (mg/kg)	**Background Limits mg/kg**						
Antimony	5.41	<0.494	<0.499	<0.499	<0.489	<0.499	<0.496
Arsenic	--	<0.0721 UJ	<0.0746 UJ	**0.325 J**	**0.268 J**	**0.109 F,J**	<0.0744 UJ
Boron	61.7	**40.6**	<2.5	**22.4**	**27.4**	**4.5 F**	**16.8**
Cadmium	1.7	**0.0284 F**	**0.109**	**0.357**	**0.644**	<0.0238	<0.0248
Chromium, Total	--	**1.29**	**1.65**	**3.63**	**4.22**	**3.15**	**2.18**
Cobalt	--	<0.12	<0.124	**0.48**	**0.36 J**	<0.119	<0.124
Copper	--	**3.16**	**3.25**	**5.79**	**4.71**	**5.59**	**5.82**
Manganese	--	**33.2**	**0.603**	**162**	**161**	**58.9**	**93.2**
Mercury	0.0526	<0.0154	<0.0159	<0.00921	<0.00963 UJ	<0.00951	**0.0142 F**
Molybdenum	5.78	<1.48	<1.5	<1.5	**1.91 J**	**2.87 F**	<1.49
Nickel	--	**1.29**	**0.962**	**1.92**	**1.68**	**0.662 F**	**0.884**
Selenium	3.41	**0.167 F**	**0.211**	**0.492**	**0.392**	**0.393**	**0.197 F,B**
Silver	0.27	<0.0481	<0.0497	<0.046	<0.0482	**0.18 F**	**0.179 F**
Thallium	0.0163	<0.00962	<0.00994	<0.00921	<0.00963	<0.00951	<0.00992
Uranium, Total	0.162	<0.0962	<0.0994	<0.0921	<0.0963	<0.0951	<0.0992
Vanadium	--	**0.366 F**	**0.445 F**	**1.41**	**1.65**	**0.518**	**0.384 F**
Zinc	--	**19.8**	**0.551 F**	**19.4**	**18.2 J-**	**24.8**	**23.6**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

TABLE B-2

SUMMARY OF UPLAND VEGETATION RESULTS
P4 RI/FS

Location Identification		MBH002-10	MBH002-10	MBH002-10	MBH002-10	MBH002-10	MBH002-10
Field Sample Identification		0906-MBH002-10-SM-AMAL	0906-MBH002-10-SL-SYAL	0906-MBH002-10-SM-SYAL	0906-MBH002-10-SL-ARTR	0906-MBH002-10-SM-ARTR	0906-MBH002-10-SL-CHNA
Date Collected		6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009
Analyte/Methods (Units)							
Metals (mg/kg)	**Background Limits mg/kg**						
Antimony	5.41	<0.962	<0.499	<1.66	<0.496	<1.17	<0.917
Arsenic	--	<0.0746 UJ	<0.0721 UJ	**0.0945 F,J**	**0.288 J**	<0.0732 UJ	**0.38 J-**
Boron	61.7	**10.1**	**52**	**39.1**	**35.2**	**20**	**45.7**
Cadmium	1.7	**0.0717 F**	<0.024	**0.142**	**0.15**	**0.227**	**0.0964 F**
Chromium, Total	--	**2.36**	**2.64**	**2.54**	**3.45**	**3.31**	**2.82**
Cobalt	--	<0.124	<0.12	**0.24 F**	**0.203 F**	<0.122	**0.423 F**
Copper	--	**4.2**	**3.89**	**6.96**	**6.03**	**6.17**	**11.8**
Manganese	--	**18.4**	**269**	**542**	**128**	**20.9**	**195**
Mercury	0.0526	<0.00994	<0.00962	<0.0098	<0.00912	**0.0672 F**	<0.00986
Molybdenum	5.78	<2.88	**2.19 F**	<4.97	<1.49	<3.51	<2.75
Nickel	--	**0.73 F**	**1.22**	**0.975**	**1.43**	**0.675 F**	**1.68**
Selenium	3.41	**0.242 B**	**0.301**	**0.199 B**	**0.76**	**0.232 B**	**0.637**
Silver	0.27	**0.0562 F**	**0.296**	**10.5**	<0.0456	<0.0488	**0.242**
Thallium	0.0163	<0.00994	<0.00962	<0.0098	<0.00912	<0.00977	<0.00986
Uranium, Total	0.162	<0.0994	<0.0962	<0.098	<0.0912	<0.0977	<0.0986
Vanadium	--	**0.614**	**0.472 F**	**0.915**	**1.09**	**0.625**	**1.49**
Zinc	--	**13**	**14.9**	**30.2**	**13.9**	**10.6**	**40**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

TABLE B-2

SUMMARY OF UPLAND VEGETATION RESULTS
P4 RI/FS

Location Identification		MBH002-10	MBH002-10	MBH002-10	MBH002-CS	MBH002-CS	MHR002
Field Sample Identification		0906-MBH002-10-SM-CHNA	0906-MBH002-10-SL-PUTR	0906-MBH002-10-SM-PUTR	0908-MBH002-CS-JUSC-LEAF	0908-MBH002-CS-JUSC-STEM	0906-MHR002-01-GF
Date Collected		6/18/2009	6/18/2009	6/18/2009	8/25/2009	8/25/2009	6/18/2009
Analyte/Methods (Units)							
Metals (mg/kg)	**Background Limits mg/kg**						
Antimony	5.41	<0.926	<0.963	<0.965	<0.498	<0.495	<0.497
Arsenic	--	**6.7 J-**	**0.0978 F,J**	**0.0866 F,J**	<0.0741 UJ	**5.45 J**	**0.125 F,J**
Boron	61.7	**26.9**	**20.7**	**26.2**	**14.2**	**9.09**	**17.6**
Cadmium	1.7	**0.109**	**0.0528 F**	**0.271**	**0.0465 J**	**0.122**	**1.81**
Chromium, Total	--	**2.24**	**2.38**	**2.89**	**2.53**	**2.59**	**3.75**
Cobalt	--	<0.123	<0.125	<0.123	<0.124	<0.12	<0.122
Copper	--	**8.49**	**9.11**	**5.29**	**4.35**	**5.41**	**6.65**
Manganese	--	**101**	**21**	**54.5**	**106**	**29.4**	**26.8**
Mercury	0.0526	<0.00984	**0.0589 F**	<0.00984	**0.0748 J-**	<0.00963 UJ	**0.0304 F**
Molybdenum	5.78	<2.78	<2.89	<2.9	<1.49	<1.48	**8.72**
Nickel	--	**0.778 F**	**1.24**	**0.965**	**0.903**	**1.07**	**4.31**
Selenium	3.41	**0.647**	**0.415**	**0.226 B**	**0.181 J**	**0.192 J**	**3.07**
Silver	0.27	**0.0743 F**	**0.368**	<0.0492	<0.0494	<0.0482	**0.0782 F**
Thallium	0.0163	<0.00984	<0.01	<0.00984	<0.00988	<0.00963	**0.189**
Uranium, Total	0.162	<0.0984	<0.1	<0.0984	<0.0988	<0.0963	<0.0977
Vanadium	--	**0.62**	**0.537**	**0.578**	**0.739**	**0.817**	**1.11**
Zinc	--	**21.7**	**15.5**	**14.6**	**23**	**15.4**	**42.4**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

TABLE B-2

SUMMARY OF UPLAND VEGETATION RESULTS
P4 RI/FS
(Page 12 of 36)

Location Identification		MHR002	MHR002	MHR002	MHR002	MHR002	MHR002	MHR002	MHR002
Field Sample Identification		0906-MHR002-02-GF	0906-MHR002-03-GF	0906-MHR002-04-FB	0908-MHR002-04-FB	0906-MHR002-04-GS	0906-MHR002-05-GF	0906-MHR002-06-GF	0906-MHR002-07-GF-1
Date Collected		6/18/2009	6/19/2009	6/19/2009	8/25/2009	6/19/2009	6/18/2009	6/18/2009	6/18/2009
Analyte/Methods (Units)									
Metals (mg/kg)	**Background Limits mg/kg**								
Antimony	5.41	<0.496	<0.5	**0.518 F**	<0.497	<0.499	<0.475	<0.487	<0.482
Arsenic	--	**0.154 F,J**	**0.169 F**	<0.073	**0.195 J**	<0.0723	**0.139 F**	**0.115 F**	**0.0976 F**
Boron	61.7	**12.5**	**11.7**	**29.9**	**14.8**	**2.52 F**	**13.7**	<2.44	**3.24 F**
Cadmium	1.7	**1.46**	**1.08**	**1.15**	**1.67**	**0.553**	**3.7**	**1.62**	**2.33**
Chromium, Total	--	**4.61**	**2.92**	**1.38**	**1.79**	**1.87**	**2.77**	**2.79**	**2.73**
Cobalt	--	<0.123	<0.121	<0.122	<0.123	<0.12	<0.124	<0.125	<0.121
Copper	--	**6.67**	**6.39**	**3.91**	**3.55**	**3.87**	**6.98**	**6.13**	**9.96**
Manganese	--	**31.6**	**41.5**	**16.9**	**15.7**	**18.5**	**19.6**	**35**	**52.4**
Mercury	0.0526	<0.00984	<0.0193	<0.0195	<0.0197	<0.0193	<0.0198	<0.02	<0.0194
Molybdenum	5.78	**4.44**	**5.17**	**3.06**	**1.56 J**	**2.23 F**	**1.96 F**	<1.46	<1.45
Nickel	--	**4.84**	**4.56**	**3.62**	**3.17**	**4.23**	**4.6**	**2.52**	**8.53**
Selenium	3.41	**1.27**	**8.26**	**2.58**	**1.28**	**1.3**	**2.78**	**3.03**	**1.31**
Silver	0.27	<0.0492	<0.0484 UJ	<0.0486 UJ	<0.0493	<0.0482 UJ	<0.0494 UJ	<0.05 UJ	<0.0484 UJ
Thallium	0.0163	**0.238**	**0.151**	**0.119**	**0.413**	**0.0958**	**0.39**	**0.115**	**0.22**
Uranium, Total	0.162	**0.173 F**	**0.157 F**	<0.0973	<0.0986	<0.0963	<0.0988	<0.1	<0.0969
Vanadium	--	**1.38**	**1.82**	**0.667**	**0.625**	**0.457 F**	**1.0**	**0.551**	**1.3**
Zinc	--	**44.2**	**61.7**	**36**	**27.9**	**56**	**81.9**	**44.5**	**86**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

Location Identification		MHR002 Dup	MHR002 Triplicate	MHR002 Average	MHR002	MHR002	MHR002	MHR002	MHR002
Field Sample Identification		0906-MHR002-07-GF-2	0906-MHR002-07-GF-3	0906-MHR002-07-GF-avg	0906-MHR002-08-GF	0906-MHR002-09-GF	0906-MHR002-10-FB	0908-MHR002-10-FB	0906-MHR002-10-GS
Date Collected		6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009	8/25/2009	6/18/2009
Analyte/Methods (Units)									
Metals (mg/kg)	**Background Limits mg/kg**								
Antimony	5.41	<0.485	<0.482	<0.485	<0.498	<0.497	<0.495	<0.492	<0.499
Arsenic	--	**0.0859 F**	**0.108 F**	**0.0972 J**	**0.113 F**	**0.073 F**	**1.53**	**9.27 J-**	**0.181 F**
Boron	61.7	<2.43	<2.41	**3.24 J**	**9.37**	**10.8**	**27.9**	**15.7**	**2.93 F**
Cadmium	1.7	**0.433**	**0.179**	**0.981**	**1.29**	**0.868**	**1.84**	**0.859 J**	**0.787**
Chromium, Total	--	**2.67**	**2.56**	**2.65**	**1.93**	**2.23**	**4.47 J**	**1.59 J**	**5.89 J**
Cobalt	--	<0.123	<0.122	<0.123	<0.123	<0.121	**0.162 F**	<0.618	<0.12
Copper	--	**4.85**	**4.05**	**6.29**	**7.45**	**6.78**	**7.43**	**3.49**	**8.29**
Manganese	--	**47.6**	**39.3**	**46.4**	**30.5**	**28.8**	**24.1**	**9.25**	**22.4**
Mercury	0.0526	<0.0196	<0.0196	<0.0196	<0.00982 UJ	<0.0193	**0.0687 F**	<0.0198	**0.0124 F**
Molybdenum	5.78	**2.49 F**	**4.38**	**3.44 J**	**11.3**	**11.3**	**13.1**	**2.91 J**	**18.8**
Nickel	--	**1.78**	**0.578 F**	**3.63 J**	**7.85**	**5.29**	**9.81**	**2.95 J-**	**3.27**
Selenium	3.41	**1.6**	**2.49**	**1.8**	**4.03 J**	**4.13**	**49 J+**	**4.1**	**3.78 J+**
Silver	0.27	<0.049 UJ	<0.0489 UJ	<0.049 UJ	<0.0491 UJ	<0.0484 UJ	<0.0488	<0.0494	<0.0478
Thallium	0.0163	<0.0098	<0.00978	**0.22**	**0.243**	**0.233**	**0.664**	**0.31**	**0.14**
Uranium, Total	0.162	<0.098	<0.0978	<0.098	<0.0982	<0.0967	<0.0977	<0.0988	<0.0956
Vanadium	--	**0.577**	**0.529**	**0.802**	**0.546**	**0.549**	**1.38**	<0.618	**1.3**
Zinc	--	**27.7**	**15.5**	**43.1**	**72.2**	**58.7**	**60.2**	**25.5**	**31**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

Location Identification		MWD085	MWD085	MWD085	MWD085	MWD085	MWD085	MWD085
Field Sample Identification		VEMWD085-1-C(5)	VEMWD085-2-C(5)	VEMWD085-3-C(5)	VEMWD085-4-C(5)	VEMWD085-5-C(5)	VEMWD085-6-C(5)	VEMWD085-7-C(6)
Date Collected		7/21/2004	7/21/2004	7/21/2004	7/21/2004	7/21/2004	7/21/2004	7/21/2004
Analyte/Methods (Units)								
Metals (mg/kg)	**Background Limits mg/kg**							
Antimony	5.41	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--
Boron	61.7	--	--	--	--	--	--	--
Cadmium	1.7	--	--	--	--	--	--	--
Chromium, Total	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--
Mercury	0.0526	--	--	--	--	--	--	--
Molybdenum	5.78	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--
Selenium	3.41	<0.5	**1.7 J**	<0.5	<0.5	<0.5	<0.5	<0.5
Silver	0.27	--	--	--	--	--	--	--
Thallium	0.0163	--	--	--	--	--	--	--
Uranium, Total	0.162	--	--	--	--	--	--	--
Vanadium	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

TABLE B-2

SUMMARY OF UPLAND VEGETATION RESULTS
P4 RI/FS

Location Identification		MWD085	MWD085	MWD085	MWD085	MWD085	MWD085	MWD085	MWD085
Field Sample Identification		VEMWD085-8-C(5)	VEMWD085-9-C(5)	VEMWD085-10-C(6)	VEMWD085-11-C(5)	VEMWD085-12-C(6)	VEMWD085-13-C(6)	VEMWD085-14-C(5)	VEMWD085-15-C(5)
Date Collected		7/21/2004	7/21/2004	7/21/2004	7/21/2004	7/21/2004	7/21/2004	7/22/2004	7/22/2004
Analyte/Methods (Units)									
Metals (mg/kg)	**Background Limits mg/kg**								
Antimony	5.41	--	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--	--
Boron	61.7	--	--	--	--	--	--	--	--
Cadmium	1.7	--	--	--	--	--	--	--	--
Chromium, Total	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--
Mercury	0.0526	--	--	--	--	--	--	--	--
Molybdenum	5.78	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	--
Selenium	3.41	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**0.7 J**
Silver	0.27	--	--	--	--	--	--	--	--
Thallium	0.0163	--	--	--	--	--	--	--	--
Uranium, Total	0.162	--	--	--	--	--	--	--	--
Vanadium	--	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--	--

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

TABLE B-2

SUMMARY OF UPLAND VEGETATION RESULTS
P4 RI/FS
(Page 16 of 36)

Location Identification		MWD085	MWD085	MWD085	MWD085	MWD085	MWD085	MWD085
Field Sample Identification		VEMWD085-16-C(5)	VEMWD085-17-C(5)	VEMWD085-18-C(5)	VEMWD085-19-C(5)	VEMWD085-20-C(5)	VEMWD085-21-C(6)	VEMWD085-22-C(5)
Date Collected		7/22/2004	7/22/2004	7/22/2004	7/22/2004	7/22/2004	7/22/2004	7/22/2004
Analyte/Methods (Units)								
Metals (mg/kg)	**Background Limits mg/kg**							
Antimony	5.41	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--
Boron	61.7	--	--	--	--	--	--	--
Cadmium	1.7	--	--	--	--	--	--	--
Chromium, Total	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--
Mercury	0.0526	--	--	--	--	--	--	--
Molybdenum	5.78	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--
Selenium	3.41	**1.9 J**	<0.6	<0.5	<0.5	<0.5	<0.5	<0.5
Silver	0.27	--	--	--	--	--	--	--
Thallium	0.0163	--	--	--	--	--	--	--
Uranium, Total	0.162	--	--	--	--	--	--	--
Vanadium	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

Location Identification		MWD085	MWD085	MWD085	MWD085	MWD085 Dup	MWD085 Triplicate	MWD085 Average
Field Sample Identification		VEMWD085-23-C(5)	VEMWD085-24-C(5)	VEMWD085-25-C(6)	EMWD085-26-C(7)QA	EMWD085-26-C(7)QA	EMWD085-26-C(7)QA	MWD085-26-C(7)QA-
Date Collected		7/22/2004	7/22/2004	7/22/2004	7/21/2004	7/21/2004	7/21/2004	7/21/2004
Analyte/Methods (Units)								
	Background Limits mg/kg							
Metals (mg/kg)								
Antimony	5.41	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--
Boron	61.7	--	--	--	--	--	--	--
Cadmium	1.7	--	--	--	--	--	--	--
Chromium, Total	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--
Mercury	0.0526	--	--	--	--	--	--	--
Molybdenum	5.78	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--
Selenium	3.41	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Silver	0.27	--	--	--	--	--	--	--
Thallium	0.0163	--	--	--	--	--	--	--
Uranium, Total	0.162	--	--	--	--	--	--	--
Vanadium	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--

mg/kg	milligrams per kilogram.
Bold	Bolded result indicates positively identified compound.
--	Not scheduled.
	Blue shaded result indicates background level exceeded.
	Yellow shaded result indicates non-detected result greater than background level.
B	Analyte detected in an associated blank.
F	Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J	Data are estimated due to associated quality control data.
J-	Data are estimated due to associated quality control data; potential low bias..
J+	Data are estimated due to associated quality control data; potential high bias.
UB	Analyte considered not detected based on associated blank data.
UJ	Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

TABLE B-2

SUMMARY OF UPLAND VEGETATION RESULTS
P4 RI/FS
(Page 18 of 36)

		MWD085	MWD085	MWD085	MWD085	MWD085	MWD085
avg	**Location Identification**						
	Field Sample Identification	**0906-MWD085-01-GF**	**0906-MWD085-02-FB**	**0908-MWD085-02-FB**	**0906-MWD085-02-GS**	**0906-MWD085-03-FB**	**0908-MWD085-03-FB**
	Date Collected	**6/17/2009**	**6/17/2009**	**8/25/2009**	**6/17/2009**	**6/16/2009**	**8/25/2009**
Analyte/Methods (Units)	**Background Limits mg/kg**						
Metals (mg/kg)							
Antimony	5.41	<0.482	<0.471	<0.499	<0.47	<0.5	<0.495
Arsenic	--	**0.0755 F**	**0.102 F**	**10.2 J-**	<0.0741	**0.0994 F**	**6.46 J-**
Boron	61.7	**6.58**	**18.8**	**46.3**	<2.35	**30.9**	**32.4**
Cadmium	1.7	**0.76 J**	**1.59 J**	**1.21 J**	**0.587 J**	**5.08**	**3.73 J**
Chromium, Total	--	**3.18**	**3.78**	**2.22**	**3.97**	**1.5**	**2.41**
Cobalt	--	<0.118	<0.116	<0.615	<0.124	**0.126 F**	<0.623
Copper	--	**4.87**	**8.59**	**3.24**	**5.42**	**9.93**	**3.73**
Manganese	--	**24.1**	**22.6**	**8.99**	**28.5**	**26.6**	**12.5**
Mercury	0.0526	<0.00943 UJ	<0.00924 UJ	<0.0197	**0.0471 F,J-**	<0.00791	<0.0199
Molybdenum	5.78	**28**	**7.53**	**5.4**	**15.7**	**15.9**	**10.9**
Nickel	--	**2.48**	**6.11**	**1.39 J-**	**1.26**	**6.87**	**3.07 J-**
Selenium	3.41	**1.24**	**2.31**	**2.48**	**0.717**	**6.29**	**9.81**
Silver	0.27	<0.0472 UJ	<0.0462 UJ	<0.0492	<0.0494 UJ	<0.0494	<0.0498
Thallium	0.0163	**0.115**	**0.153**	**0.222**	**0.158**	**0.238**	**0.347**
Uranium, Total	0.162	<0.0943	<0.0924	<0.0984	<0.0988	<0.0988	<0.0996
Vanadium	--	**0.869**	**1.39**	**0.63 J**	**1.14**	**0.58**	**0.726 J**
Zinc	--	**36.2**	**58.7**	**23.6**	**35.9**	**75.3**	**29.9**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

TABLE B-2

SUMMARY OF UPLAND VEGETATION RESULTS
P4 RI/FS
(Page 19 of 36)

Location Identification		**MWD085**	**MWD085**	**MWD085**	**MWD085**	**MWD085**	**MWD085 Dup**
Field Sample Identification		**0906-MWD085-03-GS**	**0906-MWD085-04-GF**	**0906-MWD085-05-GF**	**0906-MWD085-06-GF**	**0906-MWD085-07-GF-1**	**0906-MWD085-07-GF-2**
Date Collected		**6/16/2009**	**6/16/2009**	**6/16/2009**	**6/23/2009**	**6/17/2009**	**6/17/2009**
Analyte/Methods (Units)							
Metals (mg/kg)	**Background Limits mg/kg**						
Antimony	5.41	<0.493	<0.499	<0.497	<0.489	<0.482	<0.484
Arsenic	--	<0.0735	**0.0858 F**	**0.166 F**	<0.075 UJ	**0.0828 F**	**0.138 F**
Boron	61.7	**8.95**	**10.4**	**9.03**	**8.64**	**4.66 F**	**6.61**
Cadmium	1.7	**1.22**	**1.31**	**2.13**	**0.653**	**0.912**	**1.27 J**
Chromium, Total	--	**1.76**	**1.5**	**1.74**	**2.67**	**2.99**	**5.93**
Cobalt	--	<0.123	<0.124	<0.125	<0.125	<0.114	**0.171 F**
Copper	--	**6.36**	**7.24**	**8.14**	**7.08 J+**	**4.08**	**4.1**
Manganese	--	**54.6**	**33.6**	**31**	**31.1**	**37.6**	**49.1**
Mercury	0.0526	**0.016 F**	**0.0116 F**	**0.0124 F**	<0.02	<0.00911 UJ	<0.00988 UJ
Molybdenum	5.78	**20.7**	**12.9**	**9.67**	**8.89**	**7.21**	**4.86**
Nickel	--	**2.69**	**2.95**	**4.77**	**3.04**	**1.36**	**2.41**
Selenium	3.41	**1.21**	**1.56**	**2.49**	**1.49 J**	**3.2 J**	**4.06**
Silver	0.27	<0.049	<0.0496	<0.0499	<0.05	<0.0455	<0.0494 UJ
Thallium	0.0163	**0.215**	**0.0848**	**0.24**	**0.116**	**0.0772**	**0.139**
Uranium, Total	0.162	<0.098	<0.0992	<0.0998	<0.1	<0.0911	<0.0988
Vanadium	--	**0.309 F**	**0.269 F**	**0.367 F**	**0.771**	**0.85**	**1.62**
Zinc	--	**60.2**	**54.7**	**69**	**42.1**	**27.9 J-**	**27.3**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

TABLE B-2

SUMMARY OF UPLAND VEGETATION RESULTS
P4 RI/FS
(Page 20 of 36)

Location Identification		MWD085 Triplicate	MWD085 Average	MWD085	MWD085	MWD085
Field Sample Identification		0906-MWD085-07-GF-3	0906-MWD085-07-GF-avg	0906-MWD085-08-GF	0906-MWD085-09-GF	0906-MWD085-10-GF
Date Collected		6/17/2009	6/17/2009	6/17/2009	6/17/2009	6/17/2009
Analyte/Methods (Units)						
Metals (mg/kg)	**Background Limits mg/kg**					
Antimony	5.41	<0.483	<0.484	<0.489	<0.494	<0.484
Arsenic	--	**0.214 F**	**0.145 J**	**0.17 F**	<0.0732	**0.248 F**
Boron	61.7	**9.23**	**6.83 J**	**6.56**	**10.5**	**3.55 F**
Cadmium	1.7	**0.993 J**	**1.06 J**	**0.686 J**	**1.35**	**0.794**
Chromium, Total	--	**4.1**	**4.34**	**4.48**	**3.3**	**3.76**
Cobalt	--	<0.123	**0.171 J**	<0.118	<0.122	<0.118
Copper	--	**5.35**	**4.51**	**4.09**	**6.42**	**5.68**
Manganese	--	**35**	**40.6**	**43.1**	**18.8**	**18**
Mercury	0.0526	<0.00984 UJ	<0.00988 UJ	<0.00945 UJ	<0.00977 UJ	<0.00942 UJ
Molybdenum	5.78	**4.57**	**5.55**	**8.15**	**58.4**	**7.3**
Nickel	--	**1.91**	**1.89**	**2.13**	**5.73**	**2.51**
Selenium	3.41	**5.86**	**4.37 J**	**6.66**	**3.6 J**	**19.2 J**
Silver	0.27	<0.0492 UJ	<0.0494	<0.0473 UJ	<0.0488	<0.0471
Thallium	0.0163	**0.267**	**0.161**	**0.124**	**0.159**	**0.182**
Uranium, Total	0.162	<0.0984	<0.0988	<0.0945	<0.0977	<0.0942
Vanadium	--	**1.09**	**1.19**	**1.04**	**0.784**	**0.82**
Zinc	--	**35.1**	**30.1 J-**	**25.2**	**52.2 J-**	**28.2 J-**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus visc*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopu*
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos ore*

Location Identification		MWD086	MWD086	MWD086	MWD086	MWD086 Dup	MWD086 Triplicate	MWD086 Average
Field Sample Identification		052404VEMWD086-1-C6	061604VEMWD086-1-C(5	VEMWD086-1-C(5)	VEMWD086-1-C(5)QA1	VEMWD086-1-C(5)QA2	VEMWD086-1-C(5)QA3	VEMWD086-1-C(5)QA-avg
Date Collected		5/24/2004	6/16/2004	7/14/2004	8/16/2004	8/16/2004	8/16/2004	8/16/2004
Analyte/Methods (Units)								
Metals (mg/kg)	**Background Limits mg/kg**							
Antimony	5.41	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--
Boron	61.7	--	--	--	--	--	--	--
Cadmium	1.7	--	--	--	--	--	--	--
Chromium, Total	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--
Mercury	0.0526	--	--	--	--	--	--	--
Molybdenum	5.78	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--
Selenium	3.41	**3.5**	**6.6 J-**	**7.5**	**5.5 J-**	**5.4 J-**	**5.4 J-**	**5.43 J-**
Silver	0.27	--	--	--	--	--	--	--
Thallium	0.0163	--	--	--	--	--	--	--
Uranium, Total	0.162	--	--	--	--	--	--	--
Vanadium	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
idiflorus Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

eophilus)

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

TABLE B-2

SUMMARY OF UPLAND VEGETATION RESULTS
P4 RI/FS

Location Identification		MWD086	MWD086	MWD086	MWD086	MWD086	MWD086	MWD086
Field Sample Identification		091504VEMWD086-0-C(5)	101804VEMWD086-0-C(5)	VEMWD086-2-C(5)	VEMWD086-3-C(5)	VEMWD086-4-C(5)	VEMWD086-5-C(5)	VEMWD086-6-C(5)
Date Collected		9/15/2004	10/18/2004	7/22/2004	7/22/2004	7/22/2004	7/22/2004	7/22/2004
Analyte/Methods (Units)								
Metals (mg/kg)	**Background Limits mg/kg**							
Antimony	5.41	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--
Boron	61.7	--	--	--	--	--	--	--
Cadmium	1.7	**1.72 J+**	--	--	--	--	--	--
Chromium, Total	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--
Copper	--	**4.3 J+**	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--
Mercury	0.0526	--	--	--	--	--	--	--
Molybdenum	5.78	**13**	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--
Selenium	3.41	**1.0 J**	**0.8 J-**	<0.5	<0.5	<0.5	<0.5	<0.5
Silver	0.27	--	--	--	--	--	--	--
Thallium	0.0163	--	--	--	--	--	--	--
Uranium, Total	0.162	--	--	--	--	--	--	--
Vanadium	--	--	--	--	--	--	--	--
Zinc	--	**50**	--	--	--	--	--	--

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

TABLE B-2

SUMMARY OF UPLAND VEGETATION RESULTS
P4 RI/FS
(Page 23 of 36)

Location Identification		MWD086	MWD086	MWD086	MWD086	MWD086	MWD086	MWD086	MWD086	MWD086
Field Sample Identification		VEMWD086-7-C(5)	VEMWD086-8-C(7)	VEMWD086-9-C(6)	VEMWD086-10-C(6)	VEMWD086-11-C(5)	VEMWD086-12-C(6)	VEMWD086-13-C(8)	VEMWD086-14-C(16)	VEMWD086-15-C(9)
Date Collected		7/22/2004	7/22/2004	7/22/2004	7/22/2004	7/22/2004	7/22/2004	7/22/2004	7/22/2004	7/22/2004
Analyte/Methods (Units)										
Metals (mg/kg)	**Background Limits mg/kg**									
Antimony	5.41	--	--	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--	--	--
Boron	61.7	--	--	--	--	--	--	--	--	--
Cadmium	1.7	--	--	--	--	--	--	--	--	--
Chromium, Total	--	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--
Mercury	0.0526	--	--	--	--	--	--	--	--	--
Molybdenum	5.78	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	--	--
Selenium	3.41	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**0.9 J**	<0.5
Silver	0.27	--	--	--	--	--	--	--	--	--
Thallium	0.0163	--	--	--	--	--	--	--	--	--
Uranium, Total	0.162	--	--	--	--	--	--	--	--	--
Vanadium	--	--	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--	--	--

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

Location Identification		MWD086	MWD086 Dup	MWD086 Triplicate	MWD086 Quadruplicate	MWD086 Average	MWD086	MWD086
Field Sample Identification		VEMWD086-1-C(16)QA1	VEMWD086-1-C(16)QA2	VEMWD086-1-C(16)QA3	VEMWD086-1-C(16)QA4	VEMWD086-1-C(16)QA-avg	VEMWD086-17-C(5)	VEMWD086-18-C(5)
Date Collected		7/22/2004	7/22/2004	7/22/2004	7/22/2004	7/22/2004	7/22/2004	7/22/2004
Analyte/Methods (Units)								
	Background Limits							
Metals (mg/kg)	**mg/kg**							
Antimony	5.41	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--
Boron	61.7	--	--	--	--	--	--	--
Cadmium	1.7	--	--	--	--	--	--	--
Chromium, Total	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--
Mercury	0.0526	--	--	--	--	--	--	--
Molybdenum	5.78	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--
Selenium	3.41	**0.6 J**	<0.5	**0.6 J**	--	**0.6 J**	<0.5	<0.5
Silver	0.27	--	--	--	--	--	--	--
Thallium	0.0163	--	--	--	--	--	--	--
Uranium, Total	0.162	--	--	--	--	--	--	--
Vanadium	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

TABLE B-2

SUMMARY OF UPLAND VEGETATION RESULTS
P4 RI/FS
(Page 25 of 36)

Location Identification		MWD086	MWD086	MWD086	MWD086	MWD086	MWD086	MWD086	MWD086
Field Sample Identification		VEMWD086-19-C(5)	VEMWD086-20-C(5)	VEMWD086-21-C(5)	VEMWD086-22-C(5)	VEMWD086-23-C(5)	VEMWD086-24-C(5)	VEMWD086-25-C(5)	VEMWD086-26-C(5)
Date Collected		7/22/2004	7/22/2004	7/22/2004	7/22/2004	7/22/2004	7/22/2004	7/22/2004	7/22/2004
Analyte/Methods (Units)									
Metals (mg/kg)	**Background Limits mg/kg**								
Antimony	5.41	--	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--	--
Boron	61.7	--	--	--	--	--	--	--	--
Cadmium	1.7	--	--	--	--	--	--	--	--
Chromium, Total	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--
Mercury	0.0526	--	--	--	--	--	--	--	--
Molybdenum	5.78	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	--
Selenium	3.41	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Silver	0.27	--	--	--	--	--	--	--	--
Thallium	0.0163	--	--	--	--	--	--	--	--
Uranium, Total	0.162	--	--	--	--	--	--	--	--
Vanadium	--	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--	--

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

TABLE B-2

SUMMARY OF UPLAND VEGETATION RESULTS
P4 RI/FS
(Page 26 of 36)

Location Identification		MWD086	MWD086	MWD086	MWD086	MWD086	MWD086
Field Sample Identification		0906-MWD086-01-GF	0906-MWD086-02-GF	0906-MWD086-03-GF	0906-MWD086-04-GF	0906-MWD086-05-GF	0906-MWD086-06-GF
Date Collected		6/16/2009	6/15/2009	6/15/2009	6/15/2009	6/15/2009	6/15/2009
Analyte/Methods (Units)							
Metals (mg/kg)	**Background Limits mg/kg**						
Antimony	5.41	<0.5	<0.5	<0.5	<0.497	<0.499	<0.499
Arsenic	--	**0.108 F**	<0.0696	**0.193 F**	**0.127 F**	<0.0744	**0.0928 F**
Boron	61.7	**7.07**	**8.13**	**11.7**	**15.5**	**2.9 F**	**4.02 F**
Cadmium	1.7	**1.36**	**0.619**	**1.34**	**1.66**	**0.836**	**0.395**
Chromium, Total	--	**1.72**	**2.34**	**2.26**	**2.6**	**1.9**	**1.67**
Cobalt	--	<0.124	<0.116	<0.121	<0.124	<0.124	<0.117
Copper	--	**8.43**	**7.75**	**8.45**	**10.8**	**6.68**	**9.73**
Manganese	--	**40.7**	**32.9**	**23.8**	**27.2**	**35.1**	**27.3**
Mercury	0.0526	<0.00794	<0.0148	<0.0155	<0.0158	<0.0159	<0.015
Molybdenum	5.78	**7.32**	**4.74**	**8.68**	**12.2**	**5.36**	**4.96**
Nickel	--	**5.71**	**2.53**	**6.0**	**5.57**	**2.26**	**2.83**
Selenium	3.41	**5.98**	**1.14**	**8.6**	**7.48**	**0.765**	**3.51**
Silver	0.27	<0.0496	<0.0464	<0.0485	<0.0494	<0.0496	<0.047
Thallium	0.0163	**0.235**	**0.0452**	**0.166**	**0.186**	**0.0235**	**0.0421**
Uranium, Total	0.162	<0.0992	<0.0928	<0.0971	<0.0988	<0.0992	<0.094
Vanadium	--	**0.36 F**	**0.496**	**0.464 F**	**0.589**	**0.522**	**0.379 F**
Zinc	--	**67.2**	**35**	**64.3**	**65**	**39.5**	**28.7**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

Location Identification		MWD086	MWD086	MWD086 Dup	MWD086 Triplicate	MWD086 Average	MWD086	MWD086 Dup
Field Sample Identification		0906-MWD086-07-FB-1	0908-MWD086-07-FB-1	0908-MWD086-07-FB-2	0908-MWD086-07-FB-3	0908-MWD086-07-FB-avg	0906-MWD086-07-GS-1	0906-MWD086-07-GS-2
Date Collected		6/17/2009	8/25/2009	8/25/2009	8/25/2009	8/25/2009	6/17/2009	6/17/2009
Analyte/Methods (Units)								
Metals (mg/kg)	**Background Limits mg/kg**							
Antimony	5.41	<0.496	<0.498	<0.497	<0.492	<0.498	<0.488	<0.464
Arsenic	--	**0.112 F**	**0.0816 J**	<0.0723	<0.0737	**0.0816 J**	<0.0724	<0.0731
Boron	61.7	**23.3**	**23.9**	**24.6**	**55.1**	**34.5**	<2.44	**2.5 F**
Cadmium	1.7	**0.942**	**0.568**	**0.537**	**1.78**	**0.962**	**0.304**	**0.205**
Chromium, Total	--	**3.28**	**1.69**	**1.55**	**1.35**	**1.53**	**2.21**	**3.11**
Cobalt	--	<0.131	<0.121	<0.12	<0.123	<0.123	<0.121	<0.122
Copper	--	**5.22**	**4.72**	**3.64**	**3.43**	**3.93**	**4.68**	**4.85**
Manganese	--	**17.8**	**12.9**	**13.3**	**9.74**	**12**	**28.2**	**29.9**
Mercury	0.0526	**0.0117 F,J**	<0.0193	<0.0193	<0.0196	<0.0196	<0.00965 UJ	**0.0244 F,J**
Molybdenum	5.78	**9.59**	**6.65**	**5.34**	**20.1**	**10.7**	**8.64**	**9.91**
Nickel	--	**6.62**	**3.44**	**5.27**	**5.79**	**4.83**	**1.39**	**1.26**
Selenium	3.41	**2.17 J**	**1.88**	**3.45**	**9.11**	**4.82**	**1.8 J**	**1.09 J**
Silver	0.27	<0.0525	<0.0483	<0.0482	<0.0491	<0.0491	<0.0483	<0.0487
Thallium	0.0163	**0.208**	**0.339**	**0.339**	**0.0629**	**0.247**	**0.0164 F**	**0.0193 F**
Uranium, Total	0.162	<0.105	<0.0965	<0.0963	<0.0982	<0.0982	<0.0965	<0.0975
Vanadium	--	**0.992**	**0.565**	**0.472 J**	**0.501**	**0.513 J**	**0.51**	**0.634**
Zinc	--	**68.7 J-**	**34.1**	**41**	**38.5**	**37.9**	**25.8 J-**	**28.5 J-**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

SUMMARY OF UPLAND VEGETATION RESULTS
P4 RI/FS

Location Identification		MWD086 Triplicate	MWD086 Average	MWD086	MWD086	MWD086	MWD086
Field Sample Identification		0906-MWD086-07-GS-3	0906-MWD086-07-GS-avg	0906-MWD086-08-GF	0906-MWD086-09-GF	0906-MWD086-10-GF	0908-MWD086-CS-ARTR-LEAF
Date Collected		6/17/2009	6/17/2009	6/15/2009	6/16/2009	6/16/2009	8/25/2009
Analyte/Methods (Units)							
Metals (mg/kg)	**Background Limits mg/kg**						
Antimony	5.41	<0.472	<0.488	<0.5	<0.499	<0.499	<0.499
Arsenic	--	<0.0704	<0.0731	**0.61**	**0.429**	**0.11 F**	<0.37
Boron	61.7	<2.36	**2.5 J**	**8.74**	**11**	**5.24**	**30.5**
Cadmium	1.7	**0.252**	**0.254**	**0.702**	**0.811**	**0.688**	**0.132**
Chromium, Total	--	**2.87**	**2.73**	**1.85**	**2.34**	**1.93**	**1.49 J**
Cobalt	--	<0.117	<0.122	<0.123	<0.12	<0.118	<0.616
Copper	--	**4.52**	**4.68**	**5.21**	**7.06**	**6.16**	**3.66**
Manganese	--	**26**	**28**	**22.3**	**44.4**	**32.1**	**62.8**
Mercury	0.0526	<0.00938 UJ	**0.0244 J**	<0.0157	**0.00837 F**	**0.00761 F**	**0.0392 J-**
Molybdenum	5.78	**11.9**	**10.2**	**13.3**	**7.85**	**4.85**	**2.78 J**
Nickel	--	**0.95**	**1.2**	**2.68**	**3.31**	**1.78**	<0.986
Selenium	3.41	**1.13 J**	**1.34 J**	**46**	**35.3**	**2.42**	**0.643 J**
Silver	0.27	<0.0469	<0.0487	<0.0492	<0.048	<0.0471	<0.0493
Thallium	0.0163	**0.0131 F**	**0.0163 J**	**0.103**	**0.0382**	**0.0701**	<0.00986
Uranium, Total	0.162	<0.0938	<0.0975	<0.0984	<0.096	<0.0942	<0.0986
Vanadium	--	**0.598**	**0.581**	**0.386 F**	**0.4 F**	**0.366 F**	<0.616
Zinc	--	**24.6 J-**	**26.3 J-**	**46.8**	**37.7**	**30.1**	**16 J-**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

Location Identification		MWD086	MWD086	MWD086	MWD087	MWD087	MWD087
Field Sample Identification		0908-MWD086-CS-ARTR-STEM	0908-MWD086-CS-POTR-LEAF	0908-MWD086-CS-POTR-STEM	0906-MWD087-01-GF	0906-MWD087-02-GF	0906-MWD087-03-GF
Date Collected		8/25/2009	8/25/2009	8/25/2009	6/15/2009	6/15/2009	6/15/2009
Analyte/Methods (Units)							
Metals (mg/kg)	**Background Limits mg/kg**						
Antimony	5.41	<0.499	<0.496	<0.498	<0.5	<0.498	<0.499
Arsenic	--	<0.37	**0.111 J**	<0.074	**0.0791 F**	**1.28**	<0.0749
Boron	61.7	**13.2**	**42.2**	**17.6**	**6.5**	**3.33 F**	**7.76**
Cadmium	1.7	**0.252**	**5.56**	**5.25**	**0.821**	**0.998**	**1.08**
Chromium, Total	--	**1.56 J**	**2.15**	**1.75**	**2.36**	**2.87**	**3.73**
Cobalt	--	<0.616	**0.502**	<0.123	<0.123	<0.124	<0.125
Copper	--	**6.1**	**5.46**	**7.2**	**6.63**	**7.48**	**11.1**
Manganese	--	**20.7**	**70.1**	**32.5**	**26**	**25.3**	**12.6**
Mercury	0.0526	<0.00986 UJ	<0.00984 UJ	<0.00986 UJ	<0.0157	<0.0159	<0.016
Molybdenum	5.78	<1.5	<1.49	<1.49	**19.2**	**10.2**	**48.5**
Nickel	--	<0.986	**4.58**	**1.06**	**3.66**	**3.29**	**4.63**
Selenium	3.41	**0.504 J**	**5.26**	**1.23**	**1.56**	**146**	**0.921**
Silver	0.27	<0.0493	<0.0492	<0.0493	<0.0491	<0.0497	**0.0881 F**
Thallium	0.0163	<0.00986	<0.00984	<0.00986	**0.203**	**0.118**	**0.713**
Uranium, Total	0.162	<0.0986	<0.0984	<0.0986	<0.0982	<0.0994	<0.0998
Vanadium	--	<0.616	**0.758**	**0.454 J**	**0.46 F**	**0.519**	**0.865**
Zinc	--	**12.8 J-**	**231 J-**	**90.5 J-**	**41.6**	**53.4**	**55.2**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

TABLE B-2

SUMMARY OF UPLAND VEGETATION RESULTS
P4 RI/FS
(Page 30 of 36)

Location Identification		MWD087	MWD087	MWD087	MWD087	MWD087	MWD087	MWD087 Dup
Field Sample Identification		0906-MWD087-04-GF	0906-MWD087-05-GF	0906-MWD087-06-FB	0908-MWD087-06-FB	0906-MWD087-06-GS	0906-MWD087-07-GF-1	0906-MWD087-07-GF-2
Date Collected		6/15/2009	6/16/2009	6/16/2009	8/25/2009	6/16/2009	6/16/2009	6/16/2009
Analyte/Methods (Units)								
Metals (mg/kg)	**Background Limits mg/kg**							
Antimony	5.41	<0.496	<0.498	<0.499	<0.493	<0.499	<0.498	<0.497
Arsenic	--	**0.0742 F**	**0.126 F**	**0.17 F**	**0.0778 J**	**0.166 F**	**0.199 F**	**0.345**
Boron	61.7	**15**	**7.89**	**35.8**	**31.2**	**6.35**	**33.7**	**27.6**
Cadmium	1.7	**2.32**	**0.654**	**4.72**	**2.04**	**2.22**	**5.13**	**5.0**
Chromium, Total	--	**2.72**	**3.26**	**1.75**	**2.52**	**2.1**	**3.0**	**4.39**
Cobalt	--	<0.118	<0.124	<0.12	<0.125	<0.121	<0.118	**0.157 F**
Copper	--	**11.1**	**6.75**	**9.39**	**10.5**	**6.83**	**9.79**	**9.65**
Manganese	--	**29.4**	**19**	**24.8**	**34.9**	**20**	**20.3**	**21.9**
Mercury	0.0526	<0.0151	**0.00962 F**	**0.0122 F**	<0.02	**0.00944 F**	**0.0128 F**	**0.0165 F**
Molybdenum	5.78	**46.3**	**22.2**	**110**	**3.78**	**125**	**93.8**	**64.9**
Nickel	--	**5.64**	**2.74**	**5.95**	**2.65**	**3.61**	**9.81**	**9.27**
Selenium	3.41	**1.08**	**1.26**	**0.856**	**7.56**	**0.587**	**0.782**	**1.11**
Silver	0.27	<0.0473	<0.0497	<0.0481	<0.0499	<0.0484	<0.0473	<0.0467
Thallium	0.0163	**0.326**	**0.0587**	**0.264**	**0.013 J**	**0.0667**	**0.155**	**0.113**
Uranium, Total	0.162	<0.0945	<0.0994	<0.0962	<0.0998	<0.0967	<0.0947	**0.213 F**
Vanadium	--	**0.731**	**0.595**	**1.1**	**0.942**	**1.0**	**1.71**	**2.73**
Zinc	--	**80.6**	**47.8**	**75.1**	**72.7**	**63.8**	**90.2**	**87.2**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

TABLE B-2

SUMMARY OF UPLAND VEGETATION RESULTS
P4 RI/FS

Location Identification		MWD087 Triplicate	MWD087 Average	MWD087	MWD087	MWD087	MWD087
Field Sample Identification		0906-MWD087-07-GF-3	906-MWD087-07-GF-av	0906-MWD087-08-GF	0906-MWD087-09-GF	0906-MWD087-10-GF	0908-MWD087-CS-ARLU
Date Collected		6/16/2009	6/16/2009	6/16/2009	6/16/2009	6/16/2009	8/25/2009
Analyte/Methods (Units)							
Metals (mg/kg)	**Background Limits mg/kg**						
Antimony	5.41	<0.5	<0.5	<0.496	<0.497	<0.5	<0.5
Arsenic	--	**0.323**	**0.289 J**	**0.0871 F**	**0.0891 F**	<0.0747	**0.135 J**
Boron	61.7	**23.5**	**28.3**	**14.4**	**4.43 F**	**4.69 F**	**25.4**
Cadmium	1.7	**5.74**	**5.29**	**2.31**	**0.996**	**1.52**	**1.2**
Chromium, Total	--	**5.75**	**4.38**	**1.82**	**1.48**	**1.7**	**2.81**
Cobalt	--	**0.147 F**	**0.152 J**	<0.118	<0.123	<0.125	<0.122
Copper	--	**10.9**	**10.1**	**8.04**	**6.94**	**5.98**	**6.96**
Manganese	--	**23.4**	**21.9**	**28.1**	**28.8**	**17.3**	**30.3**
Mercury	0.0526	**0.0184 F**	**0.0159 J**	<0.00756	<0.00784	<0.00797	<0.00978 UJ
Molybdenum	5.78	**64.1**	**74.3**	**49.9**	**63**	**74.6**	<1.5
Nickel	--	**8.76**	**9.28**	**3.62**	**2.57**	**1.78**	**1.4**
Selenium	3.41	**0.725**	**0.872**	**0.752**	**0.451**	**0.628**	**1.78**
Silver	0.27	<0.0474	<0.0474	<0.0473	<0.049	<0.0498	<0.0489
Thallium	0.0163	**0.27**	**0.179**	**0.137**	**0.128**	**0.214**	<0.00978
Uranium, Total	0.162	**0.2 F**	**0.207 J**	<0.0945	<0.098	<0.0996	<0.0978
Vanadium	--	**2.69**	**2.38**	**0.507**	**0.282 F**	**0.273 F**	**1.09**
Zinc	--	**102**	**93.1**	**76.4**	**46.1**	**46.5**	**49.6**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

Location Identification		MWD088	MWD088 Dup	MWD088 Triplicate	MWD088 Average	MWD088	MWD088	MWD088
Field Sample Identification		0906-MWD088-01-GF-1	0906-MWD088-01-GF-2	0906-MWD088-01-GF-3	0906-MWD088-01-GF-avg	0906-MWD088-02-FB	0908-MWD088-02-FB	0906-MWD088-02-GS
Date Collected		6/15/2009	6/15/2009	6/15/2009	6/15/2009	6/23/2009	8/25/2009	6/23/2009
Analyte/Methods (Units)								
Metals (mg/kg)	**Background Limits mg/kg**							
Antimony	5.41	<0.499	<0.498	<0.499	<0.499	<0.492	<0.497	<0.494
Arsenic	--	**0.185 F**	**0.107 F**	**0.0928 F**	**0.128 J**	**0.156 F,J**	**7.73 J-**	<0.0749 UJ
Boron	61.7	**18.1**	**2.81 F**	**3.43 F**	**8.11 J**	**26.7**	**17.2**	**8.71**
Cadmium	1.7	**1.58**	**0.547**	**0.4**	**0.842**	**2.91**	**2.05 J**	**0.618**
Chromium, Total	--	**4.28**	**2.42**	**3.37**	**3.36**	**1.64**	**2.77**	**2.15**
Cobalt	--	<0.121	<0.121	<0.122	<0.122	<0.123	<0.616	<0.125
Copper	--	**7.34**	**4.53**	**7.91**	**6.59**	**9.79 J+**	**3.31**	**4.24 J+**
Manganese	--	**22.6**	**37.8**	**34.9**	**31.8**	**17.1**	**16.3**	**49.3**
Mercury	0.0526	<0.0154	<0.0155	<0.0156	<0.0156	<0.0196	<0.0493	<0.02
Molybdenum	5.78	**7.64**	**10.3**	**13**	**10.3**	**7.24**	**6.87**	**5.57**
Nickel	--	**9.17**	**2.02**	**2.58**	**4.59**	**5.24**	**4.32 J-**	**1.83**
Selenium	3.41	**1.85**	**0.544**	**0.692**	**1.03**	**20.2 J**	**5.61**	**2.25 J**
Silver	0.27	<0.0483	**0.0835 F**	<0.0488	**0.0835 J**	<0.049	<0.0493	<0.0499
Thallium	0.0163	**0.0829**	**0.0753**	**0.0653**	**0.0745**	**0.17**	**0.423**	**0.0986**
Uranium, Total	0.162	<0.0965	<0.0969	<0.0977	<0.0977	<0.098	<0.0986	<0.0998
Vanadium	--	**1.04**	**0.764**	**0.62**	**0.808**	**0.463 F**	**0.684 J**	**0.281 F**
Zinc	--	**44.7**	**29.8**	**37.5**	**37.3**	**65.4**	**36.8**	**46.1**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

SUMMARY OF UPLAND VEGETATION RESULTS
P4 RI/FS

	Location Identification	MWD088	MWD088	MWD088	MWD088	MWD088	MWD088
	Field Sample Identification	0906-MWD088-03-GF	0906-MWD088-04-GF	0906-MWD088-AL01-GF	0906-MWD088-06-GF	0906-MWD088-07-GF	0906-MWD088-08-GF
	Date Collected	6/15/2009	6/16/2009	6/19/2009	6/15/2009	6/16/2009	6/16/2009
Analyte/Methods (Units)							
Metals (mg/kg)	**Background Limits mg/kg**						
Antimony	5.41	<0.5	<0.499	<0.499	<0.497	<0.497	<0.499
Arsenic	--	**0.0946 F**	**0.357 J**	<0.0744	**0.114 F**	**0.172 F,J**	**0.431 J**
Boron	61.7	**6.39**	**11.4**	**5.25**	**7.84**	**7.48**	**6.38**
Cadmium	1.7	**1.4**	**2.24**	**0.96**	**0.62**	**1.18**	**1.43**
Chromium, Total	--	**2.3**	**9.23**	**2.58**	**3.62**	**3.38**	**6.16**
Cobalt	--	<0.123	**0.217 F**	<0.124	<0.124	<0.122	<0.124
Copper	--	**8.43**	**7.92**	**6.49**	**6.64**	**5.37**	**7.36**
Manganese	--	**38.5**	**30.3**	**27.7**	**54.8**	**20.5**	**45.3**
Mercury	0.0526	<0.0157	<0.0156	<0.0198	<0.0158	<0.0156	<0.0158
Molybdenum	5.78	**12.9**	**8.66**	**11.6**	**6.62**	**6.33**	**14.9**
Nickel	--	**4.38**	**8.13**	**3.87**	**1.94**	**4.16**	**7.8**
Selenium	3.41	**0.606**	**2.36**	**4.52**	**0.648**	**1.44**	**0.865**
Silver	0.27	<0.0492	**0.0546 F**	<0.0496 UJ	<0.0494	<0.0487	<0.0495
Thallium	0.0163	**0.0539**	**0.362**	**0.219**	**0.0285**	**0.236**	**0.461**
Uranium, Total	0.162	<0.0984	**0.355 F**	<0.0992	<0.0988	<0.0975	**0.165 F**
Vanadium	--	**0.835**	**2.95**	**0.579**	**0.713**	**0.741**	**2.48**
Zinc	--	**66.9**	**57.4**	**54.6**	**28.6**	**61.1**	**109**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

Location Identification		MWD088	MWD088	MWD088	MWD088	MWD090	MWD090	MWD090
Field Sample Identification		0906-MWD088-09-FB	0908-MWD088-09-FB	0906-MWD088-09-GS	0906-MWD088-10-GF	0906-MWD090-01-GF	0906-MWD090-02-FB	0908-MWD090-02-FB
Date Collected		6/23/2009	8/25/2009	6/23/2009	6/16/2009	6/16/2009	6/17/2009	8/25/2009
Analyte/Methods (Units)								
	Background Limits mg/kg							
Metals (mg/kg)								
Antimony	5.41	<0.49	<0.494	<0.493	<0.497	<0.499	<0.499	<0.499
Arsenic	--	**0.988 J**	**0.328**	**0.22 F**	**0.096 F,J**	**0.0999 F**	**0.0793 F**	<0.074
Boron	61.7	**21.4**	**22.4**	<2.46	**15.1**	**4.06 F**	**14.9**	**18**
Cadmium	1.7	**1.86**	**0.84**	**0.444**	**1.15**	**1.33**	**0.736**	**0.828**
Chromium, Total	--	**18.2**	**3.94**	**2.38**	**2.86**	**1.43**	**2.72**	**2.12**
Cobalt	--	**0.298 F**	<0.125	<0.125	<0.124	<0.119	<0.116	<0.123
Copper	--	**15.4 J+**	**7.9**	**4.26**	**8.26**	**7.52**	**6.68**	**3.53**
Manganese	--	**26.1**	**11.1**	**34.9**	**37.7**	**32.9**	**30.5**	**19.3**
Mercury	0.0526	**0.0458 F**	<0.02	<0.02 UJ	<0.0159	**0.00783 F**	<0.00929 UJ	<0.0197
Molybdenum	5.78	**5.05**	**1.71 J**	**1.53 F**	**5.42**	**7.36**	**2.95 F**	**4.47**
Nickel	--	**10**	**2.6**	**0.705 F**	**3.05**	**2.44**	**3.63**	**2.69**
Selenium	3.41	**3.36 J**	**3.29**	**2.22**	**0.472**	**4.8**	**2.77 J**	**2.62**
Silver	0.27	**0.164 F**	<0.05	<0.05	<0.0497	<0.0475	<0.0465	<0.0493
Thallium	0.0163	**0.332**	**0.135**	<0.01	**0.0573**	**0.173**	**0.0264**	**0.0364**
Uranium, Total	0.162	**1.27**	**0.286 J**	<0.1	<0.0994	<0.0951	<0.0929	<0.0986
Vanadium	--	**13.1**	**2.69**	**0.417 F**	**0.5**	**0.463 F**	**0.711**	**0.588**
Zinc	--	**55.1**	**33.6**	**17.3**	**46.6**	**49.8**	**44.5 J-**	**28.7**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

TABLE B-2

SUMMARY OF UPLAND VEGETATION RESULTS
P4 RI/FS
(Page 35 of 36)

Location Identification		MWD090	MWD090	MWD090	MWD090	MWD090	MWD090	MWD090
Field Sample Identification		0906-MWD090-02-GS	0906-MWD090-03-GF	0906-MWD090-04-FB	0908-MWD090-04-FB	0906-MWD090-04-GS	0906-MWD090-05-GF	0906-MWD090-06-GF
Date Collected		6/17/2009	6/16/2009	6/17/2009	8/25/2009	6/17/2009	6/16/2009	6/16/2009
Analyte/Methods (Units)								
	Background Limits mg/kg							
Metals (mg/kg)								
Antimony	5.41	<0.485	<0.498	<1.79	<0.489	<0.493	<0.499	<0.498
Arsenic	--	<0.0697	**0.294**	**0.428 F**	**7.21 J-**	**1.2**	**0.0854 F**	**0.159 F**
Boron	61.7	**2.71 F**	**15.4**	**47.3**	**17.6**	<2.46	**9.96**	**4.96 F**
Cadmium	1.7	**0.835**	**2.2**	**2.61**	**2.14 J**	**1.29**	**0.874**	**1.24**
Chromium, Total	--	**3.33**	**1.98**	**4.55**	**2.17**	**4.23**	**1.62**	**1.92**
Cobalt	--	<0.116	<0.115	<0.222	<0.602	<0.124	<0.12	<0.125
Copper	--	**5.15**	**6.29**	**4.35**	**4.6**	**6.06**	**6.49**	**8.09**
Manganese	--	**41.2**	**20**	**10.2**	**12.2**	**17.8**	**14.6**	**15.1**
Mercury	0.0526	**0.0237 F,J**	**0.0112 F**	<0.0178 UJ	<0.0193	<0.00992 UJ	**0.00952 F**	**0.0096 F**
Molybdenum	5.78	**2.33 F**	**10.7**	**22.1**	**23.8**	**4.85**	**22.7**	**24.9**
Nickel	--	**1.28**	**4.4**	**17.4**	**16 J-**	**3.88**	**2.27**	**3.89**
Selenium	3.41	**1.15 J**	**65.3**	**67.6 J**	**69.1**	**139 J**	**2.02**	**10.3**
Silver	0.27	<0.0465	<0.0459	<0.089	<0.0482	<0.0496	<0.048	<0.05
Thallium	0.0163	**0.0408**	**0.198**	**0.426**	**0.279**	**0.137**	**0.166**	**0.281**
Uranium, Total	0.162	<0.0929	<0.0917	<0.178	<0.0963	<0.0992	<0.096	<0.1
Vanadium	--	**0.738**	**0.476**	**1.33**	**0.661 J**	**0.722**	**0.354 F**	**0.567**
Zinc	--	**38.3 J-**	**56.4**	**65.1 J-**	**71.9**	**60 J-**	**41.3**	**48.9**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

TABLE B-2

SUMMARY OF UPLAND VEGETATION RESULTS
P4 RI/FS

Location Identification		**MWD090**	**MWD090 Duplicate**	**MWD090 Triplicate**	**MWD090 Average**	**MWD090**	**MWD090**	**MWD090**
Field Sample Identification		**0906-MWD090-07-GF1**	**0906-MWD090-07-GF2**	**0906-MWD090-07-GF3**	**0906-MWD090-07-GF-avg**	**0906-MWD090-08-GF**	**0906-MWD090-09-GF**	**0906-MWD090-10-GF**
Date Collected		**6/16/2009**	**6/16/2009**	**6/16/2009**	**6/16/2009**	**6/16/2009**	**6/16/2009**	**6/16/2009**
Analyte/Methods (Units)								
Metals (mg/kg)	**Background Limits mg/kg**							
Antimony	5.41	<0.498	<0.497	<0.492	<0.498	<0.495	<0.489	<0.498
Arsenic	--	<0.0747	**0.0932 F**	<0.0731	**0.0932 J**	**0.914**	**0.317**	**0.665 J**
Boron	61.7	**3.79 F**	**4.12 F**	**3.98 F**	**3.96 J**	**11.3**	**4.21 F**	**4.19 F**
Cadmium	1.7	**0.355**	**0.454**	**0.384**	**0.398**	**0.361**	**0.481**	**0.476**
Chromium, Total	--	**1.57**	**1.8**	**1.9**	**1.76**	**1.79**	**1.75**	**1.38**
Cobalt	--	<0.125	<0.123	<0.122	<0.125	<0.118	<0.124	<0.124
Copper	--	**6.99**	**7.22**	**7.41**	**7.21**	**8.32**	**6.74**	**5.29**
Manganese	--	**20.8**	**21.6**	**18.9**	**20.4**	**20.5**	**17.5**	**15**
Mercury	0.0526	<0.0159	**0.0166 F**	<0.0156	**0.0166 J**	**0.0191 F**	<0.0159	<0.0158
Molybdenum	5.78	**24.5**	**16.9**	**24.2**	**21.9**	**7.82**	**7.61**	**6.25**
Nickel	--	**1.2**	**1.68**	**1.91**	**1.6**	**3.61**	**2.33**	**1.91**
Selenium	3.41	**1.62**	**3.61**	**1.91**	**2.38**	**134**	**20.4**	**66**
Silver	0.27	<0.0498	<0.0493	<0.0487	<0.0498	<0.0471	<0.0497	<0.0494
Thallium	0.0163	**0.105**	**0.0807**	**0.186**	**0.124**	**0.131**	**0.131**	**0.124**
Uranium, Total	0.162	<0.0996	<0.0986	<0.0975	<0.0996	<0.0942	<0.0994	<0.0988
Vanadium	--	**0.304 F**	**0.365 F**	**0.353 F**	**0.341 J**	**0.36 F**	**0.356 F**	**0.33 F**
Zinc	--	**33.1**	**39**	**42.5**	**38.2**	**53.2**	**41.5**	**37.3**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
F Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J Data are estimated due to associated quality control data.
J- Data are estimated due to associated quality control data; potential low bias..
J+ Data are estimated due to associated quality control data; potential high bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

AMAL - serviceberry (*Amelanchier alnifolia*)
ARTR - big sagebrush (*Artemisia tridentata*)
BH - Henry Mine background
CHNA - yellow Rabbitbrush (*Chrysothamnus viscidiflorus*)*
CS - Culturally Significant plants
FB - forb
GF - grasses and forbs
GS - grass
HR - historic ore haul road
JUSC - Rocky Mountain juniper (*Juniperus scopulorum*)
POTR - quaking aspen (*Populus tremuloides*)
PUTR - antelope bitterbrush (*Purshia tridentata*)
SL - shrub leaves
SM - shrub stems
SYAL - mountain strawberry (*Symphoricarpos oreophilus*)

TABLE B-3

SUMMARY OF RIPARIAN VEGETATION RESULTS - HENRY SITE
P4 RI/FS

Location Identification		MDS016	MDS022	MSG002	MSP014	MSP015
Field Sample Identification		VEMDS016-0-C(5)	VEMDS022-0-C(5)	VEMSG002-0-C(5)	VEMSP014-0-C(5)	VEMSP015-0-C(6)
Date Collected		9/11/2004	9/10/2004	9/13/2004	9/13/2004	9/13/2004
Analyte/Methods (Units)						
Metals (mg/kg)	**Background Levels mg/kg**					
Cadmium	0.893	**0.88 J+**	**0.41**	<0.05	**0.48**	**0.17 J**
Copper	--	**2.2 J+**	**4.1**	**4.5**	**5.5**	**3.0**
Molybdenum	2.85	**2.18 J+**	**3.98**	**1.9**	**2.26**	**0.4**
Selenium	0.8	**0.7 J**	<0.5	<0.5	**3.3**	**25**
Zinc	--	**42**	**52**	**26**	**48**	**122**
Chemistry Parameters (Percent)						
Moisture, Percent	--	**42.9**	**44.9**	**61.7**	**51.4**	**52.7**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
Blue shaded result indicates background level exceeded.
-- Not scheduled.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.

TABLE B-3

SUMMARY OF RIPARIAN VEGETATION RESULTS - HENRY SITE
P4 RI/FS
(Page 2 of 7)

Analyte/Methods (Units)	Location Identification / Field Sample Identification / Date Collected	MSP016 VEMSP016-0-C(5) 9/13/2004	MSP055 VEMSP055-0-C(10) 9/13/2004	MST043 VEMST043-0-C(5) 9/11/2004	MST044 VEMST044-0-C(6) 9/14/2004	MST045 VEMST045-0-C(5) 9/14/2004
Metals (mg/kg)	**Background Levels mg/kg**					
Cadmium	0.893	**2.27**	**2.87**	<0.05	**0.26 J+**	**0.05 J+**
Copper	--	**2.6**	**7.7**	**1.9 J+**	**4.0 J+**	**4.9 J+**
Molybdenum	2.85	**0.65**	**5.49**	**1.56**	**4.51**	**0.63**
Selenium	0.8	**6.5**	**65**	<0.5	**7.9**	<0.5
Zinc	--	**35**	**335**	**11**	**31**	**36**
Chemistry Parameters (Percent)						
Moisture, Percent	--	**48.1**	**61.9**	**53.7**	**59.7**	**65.8**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
Blue shaded result indicates background level exceeded.
-- Not scheduled.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.

TABLE B-3

SUMMARY OF RIPARIAN VEGETATION RESULTS - HENRY SITE
P4 RI/FS

Analyte/Methods (Units)	Location Identification / Field Sample Identification / Date Collected	MST046 VEMST046-0-C(5) 9/13/2004	MST047 VEMST047-0-C(6) 9/13/2004	MST051 VEMST051-1-C(5)QA1 9/14/2004	MST051 Dup VEMST051-1-C(5)QA2 9/14/2004	MST051 Triplicate VEMST051-1-C(5)QA3 9/14/2004
Metals (mg/kg)	**Background Levels mg/kg**					
Cadmium	0.893	**0.37**	**0.16 J**	**0.52**	**0.5**	**0.49**
Copper	--	**5.0 J+**	**4.2 J+**	**5.4 J+**	**5.5 J+**	**5.4 J+**
Molybdenum	2.85	**1.83**	**1.5**	**3.57**	**3.44**	**3.54**
Selenium	0.8	<0.5	<0.5	<0.5	<0.5	<0.5
Zinc	--	**26**	**38**	**31**	**30**	**28**
Chemistry Parameters (Percent)						
Moisture, Percent	--	**63.5**	**54**	**62.8**	**62.8**	**62.7**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
Blue shaded result indicates background level exceeded.
-- Not scheduled.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.

TABLE B-3

SUMMARY OF RIPARIAN VEGETATION RESULTS - HENRY SITE
P4 RI/FS

Location Identification Field Sample Identification Date Collected Analyte/Methods (Units)		MST051 Average VEMST051-1-C(5)QA-avg 9/14/2004	MST052 VEMST052-0-C(5) 9/14/2004	MST053 VEMST053-1-C(5)QA1 9/13/2004	MST053 Dup VEMST053-1-C(5)QA2 9/13/2004
Metals (mg/kg)	**Background Levels mg/kg**				
Cadmium	0.893	**0.503**	**0.82 J+**	**0.3 J**	**0.31**
Copper	--	**5.43 J+**	**6.0 J+**	**4.8 J+**	**7.3 J+**
Molybdenum	2.85	**3.52**	**19.3**	**1.2**	**1.27**
Selenium	0.8	<0.5	<0.5	<0.5	<0.5
Zinc	--	**29.7**	**48**	**35**	**35**
Chemistry Parameters (Percent)					
Moisture, Percent	--	**62.8**	**52.9**	**61.1**	**61.2**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
Blue shaded result indicates background level exceeded.
-- Not scheduled.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.

TABLE B-3

SUMMARY OF RIPARIAN VEGETATION RESULTS - HENRY SITE
P4 RI/FS

Analyte/Methods (Units)	Location Identification / Field Sample Identification / Date Collected	MST053 Triplicate VEMST053-1-C(5)QA3 9/13/2004	MST053 Average VEMST053-1-C(5)QA-avg 9/13/2004	MST054 VEMST054-0-C(5) 9/13/2004	MST055 VEMST055-0-C(5) 9/12/2004	MST056 VEMST056-0-C(5) 9/13/2004
Metals (mg/kg)	**Background Levels mg/kg**					
Cadmium	0.893	**0.3**	**0.303 J**	**0.07 J**	<0.05	**0.84**
Copper	--	**5.6 J+**	**5.9 J+**	**5.5 J+**	**3.0**	**4.5 J+**
Molybdenum	2.85	**1.22**	**1.23**	**0.88**	**0.48**	**1.1**
Selenium	0.8	<0.5	<0.5	<0.5	<0.5	<0.5
Zinc	--	**34**	**34.7**	**25**	**25**	**35**
Chemistry Parameters (Percent)						
Moisture, Percent	--	**61**	**61.1**	**61.9**	**58.4**	**48.7**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
Blue shaded result indicates background level exceeded.
-- Not scheduled.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.

TABLE B-3

SUMMARY OF RIPARIAN VEGETATION RESULTS - HENRY SITE
P4 RI/FS
(Page 6 of 7)

Location Identification Field Sample Identification Date Collected Analyte/Methods (Units)		MST057 VEMST057-0-C(5) 9/13/2004	MST058 VEMST058-0-C(5) 9/13/2004	MST062 VEMST062-0-C(5) 9/12/2004	MST063 VEMST063-0-C(5) 9/14/2004	MST064 VEMST064-0-C(5) 9/13/2004
Metals (mg/kg)	**Background Levels mg/kg**					
Cadmium	0.893	<0.05	<0.05	<0.05	**0.39**	**0.49**
Copper	--	**3.7**	**4.2**	**2.1**	**5.6 J+**	**6.6**
Molybdenum	2.85	**0.72**	**1.64**	**1.19**	**1.24**	**1.38**
Selenium	0.8	**0.5 J**	<0.5	<0.5	<0.5	<0.5
Zinc	--	**36**	**19**	**13**	**36**	**45**
Chemistry Parameters (Percent)						
Moisture, Percent	--	**52.5**	**56.9**	**53.5**	**73.3**	**54.3**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
Blue shaded result indicates background level exceeded.
-- Not scheduled.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.

TABLE B-3

SUMMARY OF RIPARIAN VEGETATION RESULTS - HENRY SITE
P4 RI/FS

Location Identification		MST226	MST234	MST271	MST275	MST276
Field Sample Identification		VEMST226-0-C(5)	VEMST234-1-C(5)	VEMST271-0-C(5)	VEMST275-0-C(5)	VEMST276-0-C(5)
Date Collected		9/11/2004	9/11/2004	9/14/2004	9/14/2004	9/13/2004
Analyte/Methods (Units)						
Metals (mg/kg)	**Background Levels mg/kg**					
Cadmium	0.893	**0.73 J+**	**0.15 J**	<0.05	**0.22 J**	**0.7**
Copper	--	**5.2 J+**	**2.9**	**3.3 J+**	**4.7**	**6.5**
Molybdenum	2.85	**1.21 J+**	**3.33**	**0.71**	**1.46**	**1.17**
Selenium	0.8	<0.5	<0.5	<0.5	<0.5	<0.5
Zinc	--	**40**	**29**	**12**	**26**	**38**
Chemistry Parameters (Percent)						
Moisture, Percent	--	**60.7**	**53.7**	**53.4**	**61.9**	**63.5**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
Blue shaded result indicates background level exceeded.
-- Not scheduled.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.

TABLE B-4

SUMMARY OF RIPARIAN SOIL RESULTS - HENRY SITE
P4 RI/FS
(Page 1 of 5)

Location Identification		MDS016	MDS022	MSG002	MSP014	MSP015	MSP016	MSP055	MST043	MST044	MST045
Field Sample Identification		SSMDS016-0-C(5)	SSMDS022-0-C(5)	SSMSG002-0-C(5)	SSMSP014-0-C(5)	SSMSP015-0-C(6)	SSMSP016-0-C(5)	SSMSP055-0-C(10)	SSMST043-0-C(5)	SSMST044-0-C(6)	SSMST045-0-C(5)
Date Collected		9/11/2004	9/10/2004	9/13/2004	9/13/2004	9/13/2004	9/13/2004	9/13/2004	9/11/2004	9/14/2004	9/14/2004
Analyte/Methods (Units)											
Metals (mg/kg)	**Background Limits mg/kg**										
Antimony	5.5	--	--	--	--	--	--	--	--	--	--
Arsenic	5.93	--	--	--	--	--	--	--	--	--	--
Boron	--	--	--	--	--	--	--	--	--	--	--
Cadmium	5.02	**16.1 J**	**3.04 J**	**0.92 J+**	**5.78**	**5.67**	**20.5**	**67.3**	**0.83**	**2.84**	**0.92**
Chromium, Total	43.3	**305 J**	**24.9 J**	**29.5 J**	**48.4**	**46.2**	**164**	**467**	**24.8 J**	**46.4**	**28.4**
Cobalt	11.2	--	--	--	--	--	--	--	--	--	--
Copper	24.3	**46**	**14.3**	**21.8 J**	**23.3 J-**	**21.8 J-**	**27 J-**	**56 J-**	**8.5**	**19.9 J**	**11.2 J**
Manganese	1112	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	0.653	**7.5**	**1.34**	**0.56 J+**	**3.25**	**1.41**	**5.9**	**14.8**	**0.3 J,B**	**1.24**	**0.36**
Nickel	29.6	**147 J**	**62.6 J**	**28 J**	**42.6 J**	**48 J**	**86.5 J**	**251 J**	**20 J**	**27.5 J**	**12.4 J**
Selenium	2.03	**7.8**	**6.9**	<0.5	**11.5**	**24**	**45**	**28**	**1.1 J,B**	**5.3 J-**	**1.5 J-,B**
Silver	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.483	--	--	--	--	--	--	--	--	--	--
Uranium	3.85	--	--	--	--	--	--	--	--	--	--
Vanadium	57.9	**150**	**47.7**	**42.7 J**	**65**	**66.1**	**215**	**773**	**26.8 J**	**38.3**	**23.8**
Zinc	180	**550 J**	**143 J**	**73 J**	**231 J+**	**268 J+**	**564 J**	**1600 J**	**91**	**134**	**63**
Chemistry Parameters											
Conductivity (MMHOS/Centimeter)	--	**1.96**	**1.5**	**0.77**	**2.92**	**1.68**	**1.74**	**2.22**	**1.8**	**0.84**	**2.91**
pH, Laboratory (PH Units)	--	**7.1**	**7.6**	**7.3**	**6.7**	**7.4**	**7.2**	**7.2**	**7**	**7.3**	**7.1**
Total organic carbon (Percent)	--	**2.7**	**7.1**	**3.4**	**4.4**	**3.4**	**1.6**	**2**	**3.7**	**3.9**	**3.1**
Total solids (Percent)	--	**75.6**	**44.1**	**88.2**	**67.4**	**89.3**	**90.7**	**92.7**	**62.6**	**83.9**	**68.5**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
M Possible matrix effect.
T Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
UB Analyte considered not detected based on associated blank data.

TABLE B-4

SUMMARY OF RIPARIAN SOIL RESULTS - HENRY SITE
P4 RI/FS
(Page 2 of 5)

Analyte/Methods (Units)	Location Identification Field Sample Identification Date Collected	MST046 SSMST046-0-C(5) 9/13/2004	MST047 SSMST047-0-C(6) 9/13/2004	MST051 SSMST051-1-C(5)QA1 9/14/2004	MST051 Dup SSMST051-1-C(5)QA2 9/14/2004	MST051 Triplicate SSMST051-1-C(5)QA3 9/14/2004	MST051 Average SSMST051-1-C(5)QA-avg 9/14/2004	MST052 SSMST052-0-C(5) 9/14/2004	MST053 SSMST053-1-C(5)QA1 9/13/2004
Metals (mg/kg)	**Background Limits mg/kg**								
Antimony	5.5	--	--	--	--	--	--	--	--
Arsenic	5.93	--	--	--	--	--	--	--	--
Boron	--	--	--	--	--	--	--	--	--
Cadmium	5.02	**1.17**	**1.3**	**3.71**	**4.16**	**3.58**	**3.82**	**6.58**	**1.18**
Chromium, Total	43.3	**22.1**	**20.9**	**39.8**	**43.5**	**38.4**	**40.6**	**74.8**	**22.6**
Cobalt	11.2	--	--	--	--	--	--	--	--
Copper	24.3	**16 J**	**17 J**	**20.5 J**	**21.2 J**	**19.5 J**	**20.4 J**	**26.8 J**	**15.7 J**
Manganese	1112	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--
Molybdenum	0.653	**0.35**	**0.43**	**1.56**	**2.02**	**1.71**	**1.76**	**2.93**	**0.3 J,B**
Nickel	29.6	**13.6 J**	**13.4 J**	**28.6 J**	**31.5 J**	**27.9 J**	**29.3 J**	**46.9 J**	**12.6 J**
Selenium	2.03	**1.1 J-,B**	**1.1 J-,B**	**1.8 J-,B**	**1.8 J-,B**	**1.9 J-,B**	**1.83 J-**	**3.4 J-**	**1.0 J-,B**
Silver	--	--	--	--	--	--	--	--	--
Thallium	0.483	--	--	--	--	--	--	--	--
Uranium	3.85	--	--	--	--	--	--	--	--
Vanadium	57.9	**25.2**	**28.5**	**51.6**	**56.4**	**49.7**	**52.6**	**80.1**	**29.3**
Zinc	180	**71**	**79**	**173**	**193**	**166**	**177**	**246**	**76**
Chemistry Parameters									
Conductivity (MMHOS/Centimeter)	--	**0.95**	**1.07**	**0.43**	**0.42**	**0.42**	**0.423**	**0.67**	**1.51**
pH, Laboratory (PH Units)	--	**7.1**	**6.9**	**6.6**	**6.6**	**6.6**	**6.6**	**7.3**	**7**
Total organic carbon (Percent)	--	**5.3**	**7.1**	**3**	**3.1**	**3.1**	**3.07**	**1.8**	**6.4**
Total solids (Percent)	--	**83.4**	**80.2**	**84**	**85.2**	**83.8**	**84.3**	**88.3**	**81**

mg/kg	milligrams per kilogram.
Bold	Bolded result indicates positively identified compound.
--	Not scheduled.
	Blue shaded result indicates background level exceeded.
	Yellow shaded result indicates non-detected result greater than background level.
B	Analyte detected in an associated blank.
J	Data are estimated due to associated quality control data.
J+	Data are estimated due to associated quality control data; potential high bias.
J-	Data are estimated due to associated quality control data; potential low bias.
M	Possible matrix effect.
T	Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
UB	Analyte considered not detected based on associated blank data.

TABLE B-4

SUMMARY OF RIPARIAN SOIL RESULTS - HENRY SITE
P4 RI/FS

Location Identification Field Sample Identification Date Collected Analyte/Methods (Units)		MST053 Dup SSMST053-1-C(5)QA2 9/13/2004	MST053 Triplicate SSMST053-1-C(5)QA3 9/13/2004	MST053 Average SSMST053-1-C(5)QA-avg 9/13/2004	MST053 1010-MST053-RS-001 10/3/2010	MST053 1010-MST053-RS-002 10/3/2010	MST054 SSMST054-0-C(5) 9/13/2004	MST055 SSMST055-0-C(5) 9/12/2004
Metals (mg/kg)	**Background Limits mg/kg**							
Antimony	5.5	--	--	--	<3.0	**7.0 J**	--	--
Arsenic	5.93	--	--	--	**1.12**	**1.3**	--	--
Boron	--	--	--	--	**5.7 J**	**3.5 J**	--	--
Cadmium	5.02	**1.16**	**1.19**	**1.18**	**1.3**	**0.392**	**1.72**	**1.53**
Chromium, Total	43.3	**21.3**	**21.8**	**21.9**	**16.5**	**21.5**	**24.9**	**25.6 J**
Cobalt	11.2	--	--	--	**4.25**	**4.32**	--	--
Copper	24.3	**15.6 J**	**16.1 J**	**15.8 J**	**11.7**	**5.8**	**15.4 J**	**16.3**
Manganese	1112	--	--	--	**145**	**146**	--	--
Mercury	--	--	--	--	**0.023**	**0.024**	--	--
Molybdenum	0.653	**0.27 J,B**	**0.29 J,B**	**0.287 J**	<0.5	<0.5	**0.34**	**0.33 B**
Nickel	29.6	**11.7 J**	**11.9 J**	**12.1 J**	**10.3**	**11**	**17.5 J**	**14.1 J-**
Selenium	2.03	**0.9 J-,B**	**0.9 J-,B**	**0.933 J-**	**1.4**	**0.8 J**	**1.4 J-,B**	<0.5
Silver	--	--	--	--	**0.125**	**0.121**	--	--
Thallium	0.483	--	--	--	**0.105**	**0.11**	--	--
Uranium	3.85	--	--	--	**1.66**	**0.748**	--	--
Vanadium	57.9	**27.3**	**27.7**	**28.1**	**14.7**	**24.2**	**27.4**	**26.3 J-**
Zinc	180	**73**	**75**	**74.7**	**65.4**	**64.3**	**103**	**82**
Chemistry Parameters								
Conductivity (MMHOS/Centimeter)	--	**1.5**	**1.4**	**1.47**	--	--	**1.43**	**1.09**
pH, Laboratory (PH Units)	--	**7.1**	**7**	**7.03**	--	--	**7.3**	**6.3**
Total organic carbon (Percent)	--	**6.5**	**6.4**	**6.43**	**5**	**1.36**	**5.4**	**6.4**
Total solids (Percent)	--	**82.2**	**82.7**	**82.2**	**73.4**	--	**76.4**	**82.1**

mg/kg	milligrams per kilogram.
Bold	Bolded result indicates positively identified compound.
--	Not scheduled.
	Blue shaded result indicates background level exceeded.
	Yellow shaded result indicates non-detected result greater than background level.
B	Analyte detected in an associated blank.
J	Data are estimated due to associated quality control data.
J+	Data are estimated due to associated quality control data; potential high bias.
J-	Data are estimated due to associated quality control data; potential low bias.
M	Possible matrix effect.
T	Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
UB	Analyte considered not detected based on associated blank data.

TABLE B-4

SUMMARY OF RIPARIAN SOIL RESULTS - HENRY SITE
P4 RI/FS
(Page 4 of 5)

Location Identification		MST056	MST057	MST058	MST062	MST063	MST064	MST226	MST234	MST271	MST275
Field Sample Identification		SSMST056-0-C(5)	SSMST057-0-C(5)	SSMST058-0-C(5)	SSMST062-0-C(5)	SSMST063-0-C(5)	SSMST064-0-C(5)	SSMST226-0-C(5)	SSMST234-0-C(5)	SSMST271-0-C(5)	SSMST275-0-C(5)
Date Collected		9/13/2004	9/13/2004	9/13/2004	9/12/2004	9/14/2004	9/13/2004	9/11/2004	9/11/2004	9/14/2004	9/14/2004
Analyte/Methods (Units)											
Metals (mg/kg)	**Background Limits mg/kg**										
Antimony	5.5	--	--	--	--	--	--	--	--	--	--
Arsenic	5.93	--	--	--	--	--	--	--	--	--	--
Boron	--	--	--	--	--	--	--	--	--	--	--
Cadmium	5.02	**1.71**	**5.72 J+**	**2.46 J+**	**1.15**	**4.63**	**6.62 J+**	**2.42 J**	**0.95**	**1.75 J+**	**1.01 J+**
Chromium, Total	43.3	**28.5**	**32.2 J**	**31 J**	**25.5 J**	**47.3**	**50.7 J**	**30 J**	**25.5 J**	**33.5 J**	**25.4 J**
Cobalt	11.2	--	--	--	--	--	--	--	--	--	--
Copper	24.3	**21.2 J**	**16.8 J**	**25.2 J**	**13.5**	**26.2 J**	**21.6 J**	**17.3**	**8.2**	**20.7 J**	**15.3 J**
Manganese	1112	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	0.653	**0.38**	**0.35 J+**	**1.44 J+**	0.28 UB	**2.24**	**0.59 J+**	**0.87**	**0.33 J**	**0.33 J+**	**0.43 J+**
Nickel	29.6	**19.7 J**	**20.5 J**	**27.3 J**	**11.5 J-**	**43.7 J**	**22.8 J**	**30.7 J**	**22.9 J**	**20.3 J**	**18.4 J**
Selenium	2.03	**1.0 J-,B**	**3.1**	**1.3 J,B**	<0.5	**4.3 J-**	**1.7 J,B**	**1.4 J,B**	<0.5	<0.5	<0.5
Silver	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.483	--	--	--	--	--	--	--	--	--	--
Uranium	3.85	--	--	--	--	--	--	--	--	--	--
Vanadium	57.9	**31.6**	**30.4 J**	**36.1 J**	**20.1 J-**	**55.2**	**57 J**	**58.9**	**17.7 J**	**42.8 J**	**39.4 J**
Zinc	180	**130**	**135 J**	**111 J**	**71**	**218**	**133 J**	**120 J**	**167**	**111 J**	**57 J**
Chemistry Parameters											
Conductivity (MMHOS/Centimeter)	--	**0.47**	**1.25**	**1.22**	**0.78**	**1.56**	**1.16**	**0.587**	**1.52**	**0.45**	**1.03**
pH, Laboratory (PH Units)	--	**6.7**	**7.2**	**7.1**	**6.2**	**7.7**	**7**	**6.7**	**7.2**	**6.4**	**6.8**
Total organic carbon (Percent)	--	**4.7**	**7.1**	**11.6**	**4.5**	**8.5**	**12.1**	**7**	**3.1**	**3.9**	**5.9**
Total solids (Percent)	--	**81**	**81**	**57.8**	**85.5**	**53.1**	**76.1**	**77.5**	**82.3**	**84.3**	**78**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
M Possible matrix effect.
T Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
UB Analyte considered not detected based on associated blank data.

TABLE B-4

SUMMARY OF RIPARIAN SOIL RESULTS - HENRY SITE
P4 RI/FS
(Page 5 of 5)

Analyte/Methods (Units)	Location Identification / Field Sample Identification / Date Collected	MST275 1010-MST275A-RS-001 10/1/2010	MST275 1010-MST275A-RS-002 10/1/2010	MST275 1010-MST275B-RS-001 10/1/2010	MST275 1010-MST275B-RS-002 10/1/2010	MST276 SSMST276-0-C(5) 9/13/2004
Metals (mg/kg)	**Background Limits mg/kg**					
Antimony	5.5	**4.6 J**	**5.8 J**	**4.5 J**	**5.3 J**	--
Arsenic	5.93	**3.47**	**4.23**	**2.69**	**4.99**	--
Boron	--	**4.8 J**	**5.5 J**	**5.9 J**	**5.1 J**	--
Cadmium	5.02	**0.57**	**0.729**	**0.542**	**0.812**	**7.74 J+**
Chromium, Total	43.3	**16.9**	**14.6**	**14.4**	**15.1**	**57.6 J**
Cobalt	11.2	**7.85**	**7.38**	**6.11**	**8.73**	--
Copper	24.3	**10.5**	**11.9**	**10.6**	**10.9**	**20.4 J**
Manganese	1112	**635**	**926**	**563**	**1080**	--
Mercury	--	**0.012 J**	**0.022**	**0.015 J**	**0.021**	--
Molybdenum	0.653	1.3 UB	1.1 UB	0.6 UB	<0.5	**1.81 J+**
Nickel	29.6	**11.9**	**10.5**	**10.5**	**10.7**	**34.8 J**
Selenium	2.03	**0.8 J**	**0.8 J**	**0.7 J**	**0.8 J**	**1.5 J,B**
Silver	--	**0.099**	**0.105**	**0.098**	**0.1**	--
Thallium	0.483	**0.223**	**0.163**	**0.169**	**0.199**	--
Uranium	3.85	**1.12**	**1.14**	**0.878**	**1.4**	--
Vanadium	57.9	**25**	**22.6**	**21.4**	**23.1**	**48.4 J**
Zinc	180	**49.7**	**54.3**	**52.4**	**51.6**	**279 J**
Chemistry Parameters						
Conductivity (MMHOS/Centimeter)	--	--	--	--	--	**0.5**
pH, Laboratory (PH Units)	--	--	--	--	--	**6.4**
Total organic carbon (Percent)	--	**2.37**	**5.89**	**4.32**	**4.94**	**2.4**
Total solids (Percent)	--	--	--	--	--	**87**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
M Possible matrix effect.
T Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
UB Analyte considered not detected based on associated blank data.

TABLE B-5

SUMMARY OF SEDIMENT RESULTS - HENRY SITE
P4 RI/FS

Location Identification		MDS016	MDS022	MSP014	MSP014	MSP014 Dup	MSP014 Average	MSP014	MSP014
Field Sample Identification		052204SEMDS016-0	051804SEMDS022-0	051504SEMSP014-0	1010-MSP014-SD-001-1	1010-MSP014-SD-001-2	1010-MSP014-SD-001-avg	1010-MSP014-SD-002	1010-MSP014-SD-003
Date Collected		5/22/2004	5/18/2004	5/15/2004	9/29/2010	9/29/2010	9/29/2010	9/29/2010	9/29/2010
Analyte/Methods (Units)									
Metals (mg/kg)	**Background Levels mg/kg**								
Antimony	5	--	--	--	**5.5 J-,B**	**3.1 J-,B**	**4.3 J-,B**	**3.6 J-,B**	**8.5 J-,B**
Arsenic	4.55	--	--	--	**8.73**	**8.66**	**8.695**	**4.66**	**6.69**
Boron	8.4	--	--	--	**7.9 J**	**8.8 J**	**8.35 J**	**5.8 J**	**12.2**
Cadmium	4.17	**12.7**	**1.82**	**21**	**21.2 J**	**24.6 J**	**22.9 J**	**2.63 J**	**19.5 J**
Chromium, Total	38.1	**137**	**10.7**	**222**	**75.9**	**80**	**77.95**	**23.1**	**144**
Cobalt	--	--	--	--	**8.66**	**8.17**	**8.415**	**9.02**	**3.91**
Copper	25.5	--	--	--	**42.4**	**50.7**	**46.55**	**28.1**	**35.4**
Manganese	405	--	--	--	**382**	**395**	**388.5**	**300**	**661**
Mercury	0.038	--	--	--	**0.099**	**0.119**	**0.109**	**0.025**	**0.13**
Molybdenum	0.5	--	--	--	**4.9**	**2.9 B**	**3.9 B**	**2.2 B**	**2.4 B**
Nickel	28.7	**123 J**	**34.2**	**104**	**75.1**	**72.5**	**73.8**	**27.5**	**75.2**
Selenium	1.48	**9.7**	**1.9 J-,B**	**18.9**	**13.9 J-,B**	**14.5 J-,B**	**14.2 J-,B**	**4.9 J-,B**	**12.8 J-,B**
Silver	0.241	--	--	--	**0.886**	**1.01**	**0.948**	**0.184**	**0.938**
Thallium	0.378	--	--	--	**1.17**	**1.29**	**1.23**	**0.317**	**0.962**
Uranium	2.37	--	--	--	**15.5**	**17.8**	**16.65**	**2.87**	**22**
Vanadium	49.1	**103 J-,B**	**12.7**	**181**	**102**	**109**	**105.5**	**35.4**	**156**
Zinc	166	**371 J**	**76**	**621**	**447**	**416**	**431.5**	**126**	**456**
Metals, Simultaneously Extracted (Micro-Moles/gram)									
Cadmium, Simultaneously Extracted	--	--	--	--	**0.0397**	**0.0458**	**0.04275**	**0.0025 J**	**0.0495 J**
Copper, Simultaneously Extracted	--	--	--	--	**0.12**	**0.187**	**0.1535**	**0.0369**	**0.133**
Lead, Simultaneously Extracted	--	--	--	--	**0.01**	**0.012**	**0.011**	**0.007**	**0.008**
Nickel, Simultaneously Extracted	--	--	--	--	**0.148**	**0.192**	**0.17**	**0.03**	**0.251**
Zinc, Simultaneously Extracted	--	--	--	--	**1.03**	**1.26**	**1.145**	**0.101**	**1.6**
Chemistry Parameters									
Acid Volatile Sulfide (Micro-Moles/gram)	--	--	--	--	**0.08**	**0.16**	**0.12**	**0.01 J**	**0.385**
pH, Laboratory (PH Units)	--	**7.7**	**7.7**	**7.4**	--	--	--	--	--
Total organic carbon (Percent)	--	**1.3**	**4.2**	**2.9**	**2.3**	**2.41**	**2.355**	**3.55**	**2.83**
Total solids (Percent)	--	**73.9**	**14.5**	**55.6**	**67.9**	**67.1**	**67.5**	**62.8**	**78.1**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

TABLE B-5

SUMMARY OF SEDIMENT RESULTS - HENRY SITE
P4 RI/FS

Analyte/Methods (Units)	Location Identification / Field Sample Identification / Date Collected	MSP014 1010-MSP014-SD-004 9/29/2010	MSP014 1010-MSP014-SD-005 9/29/2010	MSP015 051804SEMSP015-0 5/18/2004	MSP015 1010-MSP015-SD-001 9/30/2010	MSP015 1010-MSP015-SD-002 9/30/2010	MSP015 1010-MSP015-SD-003 9/30/2010	MSP015 1010-MSP015-SD-004 9/30/2010	MSP016 051704SEMSP016-1-QA1 5/17/2004
Metals (mg/kg)	**Background Levels mg/kg**								
Antimony	5	**5.3 J-,B**	**8.4 J**	--	**5.5 J-,B**	**7.5 J-,B**	**7.0 J-,B**	**7.9 J-,B**	--
Arsenic	4.55	**6.83**	**8.8 J**	--	**8.82**	**6.7**	**7.7**	**8.4**	--
Boron	8.4	**9.8 J**	**13.1**	--	**7.2 J**	**6.0 J**	**5.4 J**	**6.9 J**	--
Cadmium	4.17	**16.2 J**	**28.1 J-,B**	**10.5**	**19.7 J**	**11.9 J**	**18.4 J**	**22.9 J**	**38**
Chromium, Total	38.1	**92.3**	**116**	**53**	**72.3**	**52.2**	**77.4**	**77.4**	**334**
Cobalt	--	**4.49**	**4.36 J**	--	**6.67**	**8.29**	**5.25**	**5.72**	--
Copper	25.5	**27.5**	**37.6**	--	**34.2**	**33.5**	**32.9**	**68.8**	--
Manganese	405	**827**	**788**	--	**2580**	**1350**	**1770**	**1810**	--
Mercury	0.038	**0.12**	**0.118**	--	**0.107**	**0.07**	**0.109**	**0.109**	--
Molybdenum	0.5	**4.0 B**	**10.8**	--	**5.3**	**3.0 B**	**5.2**	**5.2**	--
Nickel	28.7	**96.1**	**148**	**85.6**	**159**	**95.2**	**141**	**165**	**105**
Selenium	1.48	**24 J-,B**	**46.2 J**	**22 J-,B**	**43.4 J-,B**	**26.5 J-,B**	**35.6 J-,B**	**40.1 J-,B**	**53 J-,B**
Silver	0.241	**0.872**	**0.887**	--	**0.711**	**0.535**	**0.645**	**0.736**	--
Thallium	0.378	**0.862**	**2.17**	--	**1.12**	**0.723**	**1.14**	**1.31**	--
Uranium	2.37	**17.3**	**30.2**	--	**10.1**	**7.22**	**9.72**	**12.6**	--
Vanadium	49.1	**113**	**174**	**66**	**98.7**	**65.4**	**96.5**	**101**	**492**
Zinc	166	**500**	**979**	**602**	**1210**	**663**	**1030**	**1380**	**977**
Metals, Simultaneously Extracted (Micro-Moles/gram)									
Cadmium, Simultaneously Extracted	--	**0.0429**	**0.0701 J**	--	**0.0527 J**	**0.0233**	**0.0449**	**0.0489 J**	--
Copper, Simultaneously Extracted	--	**0.122**	**0.162**	--	**0.123**	**0.0713**	**0.109**	**0.188**	--
Lead, Simultaneously Extracted	--	**0.009**	**0.01**	--	**0.012**	**0.009**	**0.007**	**0.008**	--
Nickel, Simultaneously Extracted	--	**0.381**	**0.63**	--	**0.504**	**0.182**	**0.394**	**0.452**	--
Zinc, Simultaneously Extracted	--	**2.09**	**4.41**	--	**4.49**	**1.59**	**3.32**	**4.15**	--
Chemistry Parameters									
Acid Volatile Sulfide (Micro-Moles/gram)	--	**0.557**	**0.9**	--	**0.181**	**0.091**	**0.123**	**0.139**	--
pH, Laboratory (PH Units)	--	--	--	**7.9**	--	--	--	--	**7.4**
Total organic carbon (Percent)	--	**4.68**	**7.79**	**1**	**2.6**	**2.36**	**2.6**	**2.68**	**2.6**
Total solids (Percent)	--	**53.4**	**24.3**	**77**	**81.9**	**71.9**	**68.5**	**69.7**	**57.6**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

TABLE B-5

SUMMARY OF SEDIMENT RESULTS - HENRY SITE
P4 RI/FS
(Page 3 of 7)

Analyte/Methods (Units)	Location Identification / Field Sample Identification / Date Collected	MSP016 Dup 051704SEMSP016-1-QA2 5/17/2004	MSP016 Triplicate 051704SEMSP016-1-QA3 5/17/2004	MSP016 Average 051704SEMSP016-1-QA-avg 5/17/2004	MSP016 1010-MSP016-SD-001 9/30/2010	MSP016 1010-MSP016-SD-002 9/30/2010	MSP016 1010-MSP016-SD-003 9/30/2010	MSP016 1010-MSP016-SD-004-1 9/30/2010
Metals (mg/kg)	**Background Levels mg/kg**							
Antimony	5	--	--	--	7.4 UB	4.7 UB	9.5 UB	5.4 UB
Arsenic	4.55	--	--	--	**7.36 J**	**5.6 J**	**10.6 J**	**6.48 J**
Boron	8.4	--	--	--	**6.6 J**	**16.2**	**17.4**	**7.7 J**
Cadmium	4.17	**44.3**	**42.1**	**41.5**	**5.18 J-,B**	**54.9 J-,B**	**39.7 J-,B**	**6.77 J-,B**
Chromium, Total	38.1	**349**	**344**	**342**	**55**	**215**	**320**	**48.3**
Cobalt	--	--	--	--	**10**	**2.77**	**3.34**	**5.81**
Copper	25.5	--	--	--	**27.2**	**43.6**	**57.3**	**30.2**
Manganese	405	--	--	--	**506**	**335**	**119**	**208**
Mercury	0.038	--	--	--	**0.061**	**0.13**	**0.236**	**0.067**
Molybdenum	0.5	--	--	--	1.7 UB	**2.9 B**	**5.0 B**	1.6 UB
Nickel	28.7	**105**	**99.2**	**103**	**41.4**	**48**	**88.8**	**54.2**
Selenium	1.48	**55 J-,B**	**54 J-,B**	**54 J**	**21.3 J**	**28.9 J**	**82.5 J**	**97.4 J**
Silver	0.241	--	--	--	**0.485 J**	**1.9 J**	**2.16 J**	**0.438 J**
Thallium	0.378	--	--	--	**0.452**	**1.55**	**1.49**	**0.669**
Uranium	2.37	--	--	--	**9.77 J+**	**90 J+**	**61.9 J+**	**5.89 J+**
Vanadium	49.1	**514**	**514**	**507**	**75**	**386**	**440**	**61.3**
Zinc	166	**1010**	**939**	**975**	**171**	**490**	**608**	**279**
Metals, Simultaneously Extracted (Micro-Moles/gram)								
Cadmium, Simultaneously Extracted	--	--	--	--	**0.0071 J**	**0.0771 J**	**0.0618 J**	**0.0061 J**
Copper, Simultaneously Extracted	--	--	--	--	**0.0829**	**0.112**	**0.162**	**0.0458**
Lead, Simultaneously Extracted	--	--	--	--	**0.009**	**0.007**	**0.009**	**0.006**
Nickel, Simultaneously Extracted	--	--	--	--	**0.064 J**	**0.141 J**	**0.203 J**	**0.058 J**
Zinc, Simultaneously Extracted	--	--	--	--	**0.232**	**1.43**	**1.58**	**0.285**
Chemistry Parameters								
Acid Volatile Sulfide (Micro-Moles/gram)	--	--	--	--	**0.043**	**0.32**	**0.394**	**0.036**
pH, Laboratory (PH Units)	--	**7.4**	**7.4**	**7.4**	--	--	--	--
Total organic carbon (Percent)	--	**2.6**	**2.6**	**2.6**	**0.77**	**1.92**	**3.83**	**3.96**
Total solids (Percent)	--	**60.1**	**67.6**	**61.8**	**71.5**	**74.3**	**59.4**	**61**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potentital high bias.
J- Data are estimated due to associated quality control data; potentital low bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

TABLE B-5

SUMMARY OF SEDIMENT RESULTS - HENRY SITE
P4 RI/FS

Location Identification / Field Sample Identification / Date Collected		MSP016 Dup 1010-MSP016-SD-004-2 9/30/2010	MSP016 Average 1010-MSP016-SD-004-avg 9/30/2010	MSP055 051504SEMSP055-0 5/15/2004	MST043 052104SEMST043-QA1 5/21/2004	MST043 Dup 052104SEMST043-QA2 5/21/2004	MST043 Triplicate 052104SEMST043-QA3 5/21/2004	MST043 Average 052104SEMST043-QA-avg 5/21/2004
Analyte/Methods (Units)								
Metals (mg/kg)	**Background Levels mg/kg**							
Antimony	5	4.7 UB	5.05 UB	--	--	--	--	--
Arsenic	4.55	**5.83 J**	**6.155 J**	--	--	--	--	--
Boron	8.4	**8.0 J**	**7.85 J**	--	--	--	--	--
Cadmium	4.17	**6.47 J-,B**	**6.62 J-,B**	**104**	**1.09**	**0.74**	**0.88**	**0.903**
Chromium, Total	38.1	**47**	**47.65**	**1030**	**25.5**	**23.6**	**25.1**	**24.7**
Cobalt	--	**5.92**	**5.865**	--	--	--	--	--
Copper	25.5	**31.8**	**31**	--	--	--	--	--
Manganese	405	**187**	**197.5**	--	--	--	--	--
Mercury	0.038	**0.072**	**0.0695**	--	--	--	--	--
Molybdenum	0.5	1.2 UB	1.4 UB	--	--	--	--	--
Nickel	28.7	**51.8**	**53**	**1110**	**13.8 J**	**14.8 J**	**14.5 J**	**14.4 J**
Selenium	1.48	**96.3 J**	**96.85 J**	**148**	**1.5 J,B**	**1.4 J,B**	**2.1 J,B**	**1.67 J**
Silver	0.241	**0.444 J**	**0.441 J**	--	--	--	--	--
Thallium	0.378	**0.624**	**0.6465**	--	--	--	--	--
Uranium	2.37	**4.55 J+**	**5.22 J+**	--	--	--	--	--
Vanadium	49.1	**58.1**	**59.7**	**940**	**22.5**	**21.9**	**22.3**	**22.2**
Zinc	166	**274**	**276.5**	**7940**	**89**	**86**	**89**	**88**
Metals, Simultaneously Extracted (Micro-Moles/gram)								
Cadmium, Simultaneously Extracted	--	**0.0104 J**	**0.00825 J**	--	--	--	--	--
Copper, Simultaneously Extracted	--	**0.0836**	**0.0647**	--	--	--	--	--
Lead, Simultaneously Extracted	--	**0.011**	**0.0085**	--	--	--	--	--
Nickel, Simultaneously Extracted	--	**0.098 J**	**0.078 J**	--	--	--	--	--
Zinc, Simultaneously Extracted	--	**0.489**	**0.387**	--	--	--	--	--
Chemistry Parameters								
Acid Volatile Sulfide (Micro-Moles/gram)	--	**0.092**	**0.064**	--	--	--	--	--
pH, Laboratory (PH Units)	--	--	--	**7.5**	**7.5**	**7.6**	**7.6**	**7.57**
Total organic carbon (Percent)	--	**4.2**	**4.08**	**6.2**	**2.5**	**2.6**	**2.7**	**2.6**
Total solids (Percent)	--	**61.8**	**61.4**	**55.6**	**29.9**	**43.9**	**32.9**	**35.6**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

TABLE B-5

SUMMARY OF SEDIMENT RESULTS - HENRY SITE
P4 RI/FS
(Page 5 of 7)

Location Identification Field Sample Identification Date Collected Analyte/Methods (Units)		MST044 051904SEMST044-0 5/19/2004	MST045 051904SEMST045-0 5/19/2004	MST046 052104SEMST046-0 5/21/2004	MST047 052104SEMST047-0 5/21/2004	MST053 052104SEMST053-0 5/21/2004	MST053 1010-MST053-SD-001 10/3/2010	MST053 1010-MST053-SD-002 10/3/2010	MST054 052204SEMST054-0 5/22/2004
Metals (mg/kg)	**Background Levels mg/kg**								
Antimony	5	--	--	--	--	--	4.2 UB	**4.7 J**	--
Arsenic	4.55	--	--	--	--	--	**1.53 J**	**1.99 J**	--
Boron	8.4	--	--	--	--	--	**4.4 J**	**4.4 J**	--
Cadmium	4.17	**1.39**	**0.66**	**1.41**	**0.9**	**1.42**	**1.27 J-,B**	**1.19 J-,B**	--
Chromium, Total	38.1	**36**	**24.8**	**26.4**	**28**	**28.5**	**17.5**	**17.7**	--
Cobalt	--	--	--	--	--	--	**5.55**	**5.36**	--
Copper	25.5	--	--	--	--	--	**10.6**	**12.8**	--
Manganese	405	--	--	--	--	--	**316**	**262**	--
Mercury	0.038	--	--	--	--	--	**0.02**	**0.02**	--
Molybdenum	0.5	--	--	--	--	--	<0.5	<0.5	--
Nickel	28.7	**11.3**	**12.1**	**14.7 J**	**16.2 J**	**15.2 J**	**11.5**	**12**	**12.7 J**
Selenium	1.48	**1.1 J,B**	**1.1 J,B**	**0.5 J,B**	<0.5	<0.5	**1.3 J**	**1.3 J**	**2.0 J,B**
Silver	0.241	--	--	--	--	--	**0.119 J**	**0.117 J**	--
Thallium	0.378	--	--	--	--	--	**0.122**	**0.121**	--
Uranium	2.37	--	--	--	--	--	**2.28 J+**	**1.65 J+**	--
Vanadium	49.1	**29.3 J-,B**	**20.9 J-,B**	**26.8**	**34.3**	**29.7**	**15.7**	**16.6**	**13.7**
Zinc	166	**68 J**	**49 J**	**67**	**82**	**63**	**59.9**	**68.3**	**97**
Metals, Simultaneously Extracted (Micro-Moles/gram)									
Cadmium, Simultaneously Extracted	--	--	--	--	--	--	**0.0015**	**0.001**	--
Copper, Simultaneously Extracted	--	--	--	--	--	--	**0.0157**	**0.0264**	--
Lead, Simultaneously Extracted	--	--	--	--	--	--	**0.007**	**0.004**	--
Nickel, Simultaneously Extracted	--	--	--	--	--	--	**0.008**	**0.008**	--
Zinc, Simultaneously Extracted	--	--	--	--	--	--	**0.0603**	**0.0571**	--
Chemistry Parameters									
Acid Volatile Sulfide (Micro-Moles/gram)	--	--	--	--	--	--	**0.013 J**	**0.004 J**	--
pH, Laboratory (PH Units)	--	**7.6**	**7.1**	**7.5**	**7**	**7.2**	--	--	**7.4**
Total organic carbon (Percent)	--	**2.3**	**2.3**	**2.7**	**3.9**	**2.6**	**2.88**	**3.05**	**3.7**
Total solids (Percent)	--	**46.1**	**40.4**	**29.5**	**40.1**	**21.5**	**58.5**	**62.5**	**32.5**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potentital high bias.
J- Data are estimated due to associated quality control data; potentital low bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

TABLE B-5

SUMMARY OF SEDIMENT RESULTS - HENRY SITE
P4 RI/FS
(Page 6 of 7)

Location Identification		MST055	MST057	MST058	MST062	MST063	MST064	MST234	MST234 Dup
Field Sample Identification		051904SEMST055-0	051804SEMST057-0	051804SEMST058-0	051804SEMST062-0	051804SEMST063-0	051804SEMST064-0	052004SEMST234-1-QA1	052004SEMST234-1-QA2
Date Collected		5/19/2004	5/18/2004	5/18/2004	5/18/2004	5/18/2004	5/18/2004	5/20/2004	5/20/2004
Analyte/Methods (Units)									
Metals (mg/kg)	**Background Levels mg/kg**								
Antimony	5	--	--	--	--	--	--	--	--
Arsenic	4.55	--	--	--	--	--	--	--	--
Boron	8.4	--	--	--	--	--	--	--	--
Cadmium	4.17	**2.16**	**4.48**	**2.1**	**1.05**	**1.73**	**5.65**	**0.81**	**0.74**
Chromium, Total	38.1	**35.4**	**24.4**	**14.2**	**15.7**	**24.1**	**50**	**20.7**	**23.5**
Cobalt	--	--	--	--	--	--	--	--	--
Copper	25.5	--	--	--	--	--	--	--	--
Manganese	405	--	--	--	--	--	--	--	--
Mercury	0.038	--	--	--	--	--	--	--	--
Molybdenum	0.5	--	--	--	--	--	--	--	--
Nickel	28.7	**14.4 J**	**15**	**19.7**	**8.6**	**20.3**	**12.9**	**16.2 J**	**12.8 J**
Selenium	1.48	**1.0 J,B**	**4.4 J-,B**	**2.0 J-,B**	<0.6 UJ	<0.6 UJ	**0.8 J-,B**	**1.7 J,B**	**1.9 J,B**
Silver	0.241	--	--	--	--	--	--	--	--
Thallium	0.378	--	--	--	--	--	--	--	--
Uranium	2.37	--	--	--	--	--	--	--	--
Vanadium	49.1	**40.6 J-,B**	**27.5**	**24.9**	**13.3**	**30.9**	**52**	**13.4**	**12.7**
Zinc	166	**67 J**	**93**	**82**	**43**	**73**	**83**	**98**	**102**
Metals, Simultaneously Extracted (Micro-Moles/gram)									
Cadmium, Simultaneously Extracted	--	--	--	--	--	--	--	--	--
Copper, Simultaneously Extracted	--	--	--	--	--	--	--	--	--
Lead, Simultaneously Extracted	--	--	--	--	--	--	--	--	--
Nickel, Simultaneously Extracted	--	--	--	--	--	--	--	--	--
Zinc, Simultaneously Extracted	--	--	--	--	--	--	--	--	--
Chemistry Parameters									
Acid Volatile Sulfide (Micro-Moles/gram)	--	--	--	--	--	--	--	--	--
pH, Laboratory (PH Units)	--	**7**	**7.1**	**8.3**	**7.1**	**6.8**	**7.2**	**7.2**	**7.2**
Total organic carbon (Percent)	--	**2.7**	**5.4**	**12.3**	**2.8**	**3.3**	**2**	**2.2**	**2.2**
Total solids (Percent)	--	**51.9**	**34.8**	**11.5**	**37.2**	**44.4**	**41.3**	**40.3**	**39.5**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

TABLE B-5

SUMMARY OF SEDIMENT RESULTS - HENRY SITE
P4 RI/FS

Location Identification		MST234 Triplicate	MST234 Average	MST275	MST275	MST275	MST276
Field Sample Identification		052004SEMST234-1-QA3	052004SEMST234-1-QA-avg	051804SEMST275-0	1010-MST275A-SD-001	1010-MST275B-SD-001	051804SEMST276-0
Date Collected		5/20/2004	5/20/2004	5/18/2004	10/1/2010	10/1/2010	5/18/2004
Analyte/Methods (Units)							
Metals (mg/kg)	**Background Levels mg/kg**						
Antimony	5	--	--	--	**5.9 J**	**4.7 J**	--
Arsenic	4.55	--	--	--	**2.99 J**	**3.36 J**	--
Boron	8.4	--	--	--	**6.0 J**	**5.4 J**	--
Cadmium	4.17	**1.28**	**0.943**	**1.42**	**0.481 J-,B**	**0.488 J-,B**	**4.27**
Chromium, Total	38.1	**26.5**	**23.6**	**18.9**	**21.4**	**23**	**86**
Cobalt	--	--	--	--	**8.53**	**10.6**	--
Copper	25.5	--	--	--	**51.3**	**16.8**	--
Manganese	405	--	--	--	**580**	**620**	--
Mercury	0.038	--	--	--	**0.021**	**0.023**	--
Molybdenum	0.5	--	--	--	0.8 UB	0.5 UB	--
Nickel	28.7	**15.1 J**	**14.7 J**	**33.1**	**16.6**	**18.9**	**12.5**
Selenium	1.48	**0.8 J,B**	**1.47 J**	<0.6 UJ	**1.1 J**	**1.4 J**	**2.0 J-,B**
Silver	0.241	--	--	--	**0.161 J**	**0.16 J**	--
Thallium	0.378	--	--	--	**0.208**	**0.229**	--
Uranium	2.37	--	--	--	**1.88 J+**	**1.89 J+**	--
Vanadium	49.1	**24.6**	**16.9**	**40**	**29.9**	**30.8**	**56.5**
Zinc	166	**78**	**92.7**	**45**	**67.9**	**56.3**	**42**
Metals, Simultaneously Extracted (Micro-Moles/gram)							
Cadmium, Simultaneously Extracted	--	--	--	--	**0.0005 J**	**0.0005 J**	--
Copper, Simultaneously Extracted	--	--	--	--	**0.0678**	**0.0216**	--
Lead, Simultaneously Extracted	--	--	--	--	**0.004**	**0.004**	--
Nickel, Simultaneously Extracted	--	--	--	--	**0.011 J**	**0.015 J**	--
Zinc, Simultaneously Extracted	--	--	--	--	**0.0367**	**0.0215**	--
Chemistry Parameters							
Acid Volatile Sulfide (Micro-Moles/gram)	--	--	--	--	<0.004	<0.004	--
pH, Laboratory (PH Units)	--	**7.1**	**7.17**	**6.7**	--	--	**7.3**
Total organic carbon (Percent)	--	**2.4**	**2.27**	**2.5**	**3**	**2.51**	**1.4**
Total solids (Percent)	--	**40**	**39.9**	**51.9**	**57.5**	**51.1**	**66.4**

mg/kg milligrams per kilogram.
Bold Bolded result indicates positively identified compound.
-- Not scheduled.
Blue shaded result indicates background level exceeded.
Yellow shaded result indicates non-detected result greater than background level.
B Analyte detected in an associated blank.
J Data are estimated due to associated quality control data.
J+ Data are estimated due to associated quality control data; potential high bias.
J- Data are estimated due to associated quality control data; potential low bias.
UB Analyte considered not detected based on associated blank data.
UJ Potential low bias, possible false negative.

TABLE B-6a

SUMMARY OF SURFACE (UPSTREAM) WATER RESULTS - HENRY SITE
P4 RI/FS
(Page 1 of 10)

Analyte/Methods (Units)		Location Identification / Location Type / Date Collected	MDS016 Dump Seep 5/22/2004		MDS016 Dump Seep 5/8/2006		MDS016 Dump Seep 5/8/2007		MDS022 Dump Seep 5/18/2004		MDS022 Dump Seep 9/10/2004		MDS022 Dump Seep 5/8/2006	
Metals (mg/l)	**Background mg/l**	**Screening[a] mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	0.272	0.087	--	--	**0.03 J,K,B**	--	--	<0.03 K	--	--	--	--	<0.03 K	--
Antimony	--	0.0056	--	--	<0.0004 K	--	--	--	--	--	--	--	**0.0023 J,K,B**	--
Arsenic	0.00109	0.0062	--	--	**0.0006 J,K,B**	--	--	--	--	--	--	--	<0.0005 K	--
Barium	0.0953	--	--	--	**0.034 J,K,B**	--	--	--	--	--	--	--	**0.024 J,K,B**	--
Beryllium	0.002	--	--	--	<0.002 K	--	--	--	--	--	--	--	<0.002 K	--
Boron	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.0001	0.0013	<0.0002 K	--	**0.0008 J,K,B**	**0.0008 J,K,B**	**0.0002 J,K,B**	--	<0.0001 K	--	<0.0001 K	--	<0.0001 K	<0.0001 K
Chromium, Total	0.00284	0.011	<0.0002 K	--	**0.0003 J,K,B**	**0.0005 J,K,B**	<0.0001 K	--	--	--	<0.0001 UJ,K	--	**0.0002 J,K,B**	**0.0003 J,K,B**
Cobalt	0.01	--	--	--	<0.01 K	--	--	--	--	--	--	--	<0.01 K	--
Copper	0.01	0.037	--	--	<0.01 K	--	--	--	--	--	--	--	<0.01 K	--
Iron	0.112	0.3	--	--	<0.02 K	--	--	--	--	--	--	--	<0.02 K	--
Lead	--	0.011	--	--	<0.0001 K	--	--	--	--	--	--	--	<0.0001 K	--
Manganese	0.0552	0.05	--	--	**0.14 J,K,B**	--	--	--	--	--	--	--	**0.0295 J,K,B**	--
Mercury	--	0.00077	--	--	<0.0002	--	--	--	--	--	--	--	<0.0002	--
Molybdenum	0.01	--	--	--	<0.01 K	--	--	--	--	--	--	--	<0.01 K	--
Nickel	0.0027	0.17	**0.0129 J,K,B**	--	**0.0069 J,K,B**	**0.0069 J,K,B**	**0.0176 J,K,B**	--	**0.0057 J,K,B**	--	**0.0085 J,K,B**	--	**0.0035 J,K,B**	**0.0035 J,K,B**
Selenium	0.000772	0.0031/0.0015[b]	<0.001	<0.001	**0.02**	**0.018**	--	<0.001	--	<0.001	<0.001	<0.001	**0.004 J,B**	**0.005**
Silver	0.01	0.037	--	--	<0.01 K	--	--	--	--	--	--	--	<0.01 K	--
Thallium	0.00015	0.00024	--	--	<0.0001 K	--	--	--	--	--	--	--	<0.0001 K	--
Uranium	0.00118	--	--	--	**0.0108 J,K,B**	--	**0.0127 J,K,B**	--	--	--	--	--	**0.0119 J,K,B**	--
Vanadium	0.00491	--	0.0004 UB,K	--	**0.0022 J,K,B**	**0.0011 J,K,B**	<0.0002 K	--	0.00013 UB,K	--	<0.00005 K	--	**0.0004 J,K,B**	<0.0002 K
Zinc	0.0147	0.38	**0.008 J,K,B**	--	**0.016 J,K,B**	**0.014 J,K,B**	**0.008 J,K,B**	--	<0.002 K	--	**0.002 J,K,B**	--	**0.003 J,K,B**	<0.002 K
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	**263**	--	**385**	--	**390**	--	**407**	--	**567**	--	**384**
Alkalinity, Carbonate	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0
Alkalinity, Hydroxide (as $CaCO_3$)	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0
Alkalinity, Total (as $CaCO_3$)	--	--	--	**263**	--	**385**	--	**390**	--	**407**	--	**567**	--	**384**
Calcium	98.1	--	**281 J,K,B**	--	**201 J,K,B**	--	**237 J,K,B**	--	**124 J,K,B**	--	**143 J,K,B**	--	**116 J,K,B**	--
Chloride (as Cl)	--	--	**1.3 J,B**	--	**1.2 J,B**	--	**0.8 J,B**	--	**3.6**	--	**5.5**	--	**2.5 J,B**	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as $CaCO_3$)	--	--	--	--	**639**	--	**762**	--	--	--	--	--	**423**	--
Magnesium	20.2	--	**52.2 J,K,B**	--	**33.2 J,K,B**	--	**41.3 J,K,B**	--	**46.8 J,K,B**	--	**56.4 J,K,B**	--	**32.4 J,K,B**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	**0.2 J,B**	--	--	--	--	--	--	--	**0.2 J,B**
Nitrogen, nitrate-nitrite	--	--	--	--	--	<0.02	--	--	--	--	--	--	--	<0.02
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	**0.09 J**	--	--	--	--	--	--	--	**0.04 J,B**	--
Potassium	3	--	**1.1 J,K,B**	--	**1.8 J,K,B**	--	**1.7 J,K,B**	--	**1.4 J,K,B**	--	**1.9 J,K,B**	--	**1.7 J,K,B**	--
Sodium	--	--	**9.3 J,K,B**	--	**6.7 J,K,B**	--	**8.7 J,K,B**	--	**14.2 J,K,B**	--	**16.7 J,K,B**	--	**10.3 J,K,B**	--
Sulfate (as SO_4)	--	--	**350**	--	**239**	--	**375**	--	**60.4**	--	**48.8 J**	--	**51.1**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	<5.0	--	--	--	--	--	--	--	<5.0
Total dissolved solids (Residue, filterable)	--	--	--	--	**750**	--	--	--	--	--	--	--	**440**	--
Total organic carbon	--	--	--	--	--	**18**	--	--	--	--	--	--	--	**6.0**

TABLE B-6a

SUMMARY OF SURFACE (UPSTREAM) WATER RESULTS - HENRY SITE
P4 RI/FS

Analyte/Methods (Units)		Location Identification / Location Type / Date Collected	MDS022 Dump Seep 5/3/2007		MDS022 Dump Seep 9/13/2007		MDS022 Dump Seep 5/14/2008		MDS022 Dump Seep 9/19/2008		MDS034 Dump Seep 5/22/2008		MDS034 Dump Seep 5/31/2009	
Metals (mg/l)	**Background mg/l**	**Screening[a] mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	0.272	0.087	--	**0.06 J-,B,K**	<0.03 K	**1.12 J,K,B**	<0.03 K	**0.11 J-,B,K**	<0.05	**1.09**	<0.03 K	**0.15 J,K,B**	--	--
Antimony	--	0.0056	--	--	<0.0004 UJ,K	<0.0004 K	<0.0004 K	<0.0004 K	--	--	**0.0004 J,K,B**	**0.0005 J,K,B**	--	--
Arsenic	0.00109	0.0062	--	--	**0.0012 J,K,B**	**0.0013 J,K,B**	**0.001 J-,B,K**	**0.0005 J,K,B**	--	--	**0.0079 J,K,B**	**0.0059 J,K,B**	--	--
Barium	0.0953	--	--	--	**0.071 J,K,B**	**0.078 J,K,B**	**0.036 J,K,B**	**0.041 J,K,B**	--	--	**0.058 J,K,B**	**0.058 J,K,B**	--	--
Beryllium	0.002	--	--	--	<0.002 K	<0.002 K	<0.002 K	<0.002 K	--	--	<0.002 K	<0.002 K	--	--
Boron	0.02	--	--	--	**0.02 J,K,B**	**0.02 J,K,B**	**0.01 J,K,B**	**0.02 J,K,B**	--	--	**0.01 J,K,B**	**0.02 J,K,B**	--	--
Cadmium	0.0001	0.0013	<0.0001 K	--	<0.0001 K	**0.0005 J,K,B**	<0.0001 K	<0.0001 K	<0.000125	**0.000304 F**	**0.0005 J,K,B**	**0.0009 J,K,B**	**0.000129 F**	**0.000184 F**
Chromium, Total	0.00284	0.011	<0.0001 K	--	**0.0004 J,K,B**	<0.0005 K	<0.0001 K	<0.0001 K	0.000807 F,UB	**0.00422 B**	<0.0001 K	0.002 UB,K	--	--
Cobalt	0.01	--	--	--	<0.01 K	<0.01 K	<0.01 K	<0.01 K	--	--	<0.01 K	<0.01 K	--	--
Copper	0.01	0.037	--	--	<0.01 K	<0.01 K	<0.01 K	<0.01 K	--	--	<0.01 K	<0.01 K	--	--
Iron	0.112	0.3	--	--	<0.02 K	**1.37 J,K,B**	<0.02 K	**1.47 J,K,B**	<0.025	**1.4**	**0.16 J,K,B**	**0.8 J,K,B**	--	--
Lead	--	0.011	--	--	0.0001 UB,K	**0.0006 B,K**	<0.0001 K	<0.0001 K	--	--	<0.0001 K	0.0001 UB,K	--	--
Manganese	0.0552	0.05	--	--	**0.538 J,K,B**	**0.615 J,K,B**	**0.114 J,K,B**	**0.172 J,K,B**	**0.264**	**0.526**	**0.0714 J,K,B**	**0.0791 J,K,B**	--	--
Mercury	--	0.00077	--	--	<0.0002	<0.0002	<0.0002	<0.0002	--	--	<0.0002	<0.0002	--	--
Molybdenum	0.01	--	--	--	<0.01 K	<0.01 K	<0.01 K	<0.01 K	--	--	**0.03 J,K,B**	**0.03 J,K,B**	--	--
Nickel	0.0027	0.17	**0.0072 J,K,B**	--	**0.0084 J,K,B**	**0.011 J,K,B**	**0.0079 J,K,B**	**0.0107 J,K,B**	**0.00927**	**0.012**	**0.0116 J,K,B**	**0.0134 J,K,B**	--	--
Selenium	0.000772	0.0031/0.0015[b]	--	<0.001	<0.001	<0.001	<0.001	<0.001	**0.00357**	**0.00347**	**0.14**	**0.14**	--	**0.0505**
Silver	0.01	0.037	--	--	<0.01 K	<0.01 K	<0.01 UJ,K	<0.01 K	--	--	<0.01 K	<0.01 K	--	--
Thallium	0.00015	0.00024	--	--	0.0001 UB,K	<0.0001 K	<0.0001 K	0.0002 UB,K	--	--	<0.0001 K	0.0004 UB,K	--	--
Uranium	0.00118	--	**0.0093 J,K,B**	--	**0.0024 J,K,B**	**0.0024 J,K,B**	**0.0107 J,K,B**	**0.0097 J,K,B**	--	--	**0.0061 J,K,B**	**0.0076 J,K,B**	--	--
Vanadium	0.00491	--	0.0004 UB,K	--	**0.002 J,K,B**	**0.0039 J,K,B**	0.0003 UB,K	**0.0004 J,K,B**	<0.005	<0.005	**0.0088 J,K,B**	**0.01 J,K,B**	--	<0.005
Zinc	0.0147	0.38	**0.002 J,K,B**	--	<0.002 K	**0.025 J,K,B**	<0.002 K	0.003 UB,K	**0.00547 F**	**0.024 F**	**0.019 J,K,B**	**0.018 J,K,B**	--	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	**386**	--	**470**	--	**343**	--	--	--	**278**	--	--
Alkalinity, Carbonate	--	--	--	**14 J,B**	--	**25**	--	**13 J,B**	--	--	--	<2.0	--	--
Alkalinity, Hydroxide (as $CaCO_3$)	--	--	--	<2.0	--	<2.0	--	<2.0	--	--	--	<2.0	--	--
Alkalinity, Total (as $CaCO_3$)	--	--	--	**400**	--	**495**	--	**356**	**485**	--	--	**278**	--	--
Calcium	98.1	--	**106 J,K,B**	--	**99.3 J,K,B**	**105 J,K,B**	**113 J,K,B**	**114 J,K,B**	**117**	--	**130 J-,K**	**132 J-,K**	**112**	--
Chloride (as Cl)	--	--	**3.7**	--	**7.3**	--	**3.1**	--	**5.47**	--	1.8 UB	--	**2.59**	--
Fluoride	--	--	--	--	**0.2 J,B**	--	**0.3 J,B**	--	--	--	**0.3 J,B**	--	--	--
Hardness (as $CaCO_3$)	--	--	**430**	--	**483**	--	**418**	**421**	**532**	--	**487**	**490**	--	--
Magnesium	20.2	--	**40.2 J,K,B**	--	**57.1 J,K,B**	**58.3 J,K,B**	**32.9 J,K,B**	**33.1 J,K,B**	**58.2**	--	**39.3 J,K,B**	**38.9 J,K,B**	**40.3**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	**0.5 J-,B**	--	**0.2 J,B**	--	--	--	**0.9 J-,B**	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	<0.02	--	**0.02 J,B**	--	--	--	**0.07 J,B**	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	**0.04 J-,B**	--	**0.03 J-,B**	--	--	--	**0.23 J-**	--	--	--
Potassium	3	--	**1.9 J,K,B**	--	**5.1 J,K,B**	**5.6 J,K,B**	**2.2 J,K,B**	**2.1 J,K,B**	**0.806 F**	--	**2.6 J,K,B**	**2.6 J,K,B**	**3.05**	--
Sodium	--	--	**13.9 J,K,B**	--	**18.3 J,K,B**	**19.1 J,K,B**	**10.6 J,K,B**	**10.6 J,K,B**	**19**	--	**4.3 J,K,B**	**4.3 J,K,B**	**4.52**	--
Sulfate (as SO_4)	--	--	**62.3**	--	**18**	--	**48.9**	--	**78.4**	--	**183**	--	**141**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	**40**	--	**6.0 J,B**	--	**34**	--	<5.0	--	--
Total dissolved solids (Residue, filterable)	--	--	--	--	**510 J-**	--	**450 J-**	--	--	**582**	**570 J-**	--	--	**636**
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-6a

SUMMARY OF SURFACE (UPSTREAM) WATER RESULTS - HENRY SITE
P4 RI/FS
(Page 3 of 10)

Analyte/Methods (Units)	Location Identification / Location Type / Date Collected		MDS034 Dump Seep 5/16/2010		MDS034 Dump Seep 4/24/2013		MDS034 Dump Seep 5/9/2014		MSG002 Spring 5/8/2006		MSG002 Spring 5/3/2007		MSG002 Spring 9/18/2008	
Metals (mg/l)	**Background mg/l**	**Screening[a] mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	0.272	0.087	--	--	--	--	--	--	<0.03 K	--	--	<0.03 K	<0.05	**0.939**
Antimony	--	0.0056	--	--	--	--	--	--	**0.0006 J,K,B**	--	--	--	--	--
Arsenic	0.00109	0.0062	--	--	--	--	--	--	**0.0013 J,K,B**	--	--	--	--	--
Barium	0.0953	--	--	--	--	--	--	--	**0.054 J,K,B**	--	--	--	--	--
Beryllium	0.002	--	--	--	--	--	--	--	<0.002 K	--	--	--	--	--
Boron	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.0001	0.0013	<0.0003	**0.000438 J**	<0.0003	--	<0.0003	--	<0.0001 K	<0.0001 K	<0.0001 K	--	<0.000125	<0.000125
Chromium, Total	0.00284	0.011	--	--	--	--	--	--	**0.0002 J,K,B**	**0.0004 J,K,B**	<0.0001 K	--	**0.0026**	**0.00375**
Cobalt	0.01	--	--	--	--	--	--	--	<0.01 K	--	--	--	--	--
Copper	0.01	0.037	--	--	--	--	--	--	<0.01 K	--	--	--	--	--
Iron	0.112	0.3	--	--	--	--	--	--	<0.02 K	--	--	--	<0.025	**0.758**
Lead	--	0.011	--	--	--	--	--	--	<0.0001 K	--	--	--	--	--
Manganese	0.0552	0.05	--	--	--	--	--	--	**0.281 J,K,B**	--	--	--	**0.0336**	**0.113**
Mercury	--	0.00077	--	--	--	--	--	--	<0.0002	--	--	--	--	--
Molybdenum	0.01	--	--	--	--	--	--	--	<0.01 K	--	--	--	--	--
Nickel	0.0027	0.17	--	--	--	--	--	--	**0.0019 J,K,B**	**0.0022 J,K,B**	**0.0021 J,K,B**	--	**0.00291 F**	**0.00319 F**
Selenium	0.000772	0.0031/0.0015[b]	--	**0.0475**	**0.0977**	**0.101**	**0.0226**	**0.0164**	<0.001	**0.001 J,B**	--	**0.012**	**0.0159 J**	**0.0161 J**
Silver	0.01	0.037	--	--	--	--	--	--	<0.01 K	--	--	--	--	--
Thallium	0.00015	0.00024	--	--	--	--	--	--	<0.0001 K	--	--	--	--	--
Uranium	0.00118	--	--	--	--	--	--	--	**0.0014 J,K,B**	--	0.0005 UB,K	--	--	--
Vanadium	0.00491	--	--	<0.005	**0.00804 F**	--	**0.00556 F**	--	**0.0013 J,K,B**	**0.0005 J,K,B**	0.0007 UB,K	--	<0.005	<0.005
Zinc	0.0147	0.38	--	--	--	--	--	--	**0.003 J,K,B**	**0.005 J,K,B**	**0.038 J,K,B**	--	<0.005	**0.00658 F**
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	--	--	--	--	--	--	**261**	--	**167**	--	--
Alkalinity, Carbonate	--	--	--	--	--	--	--	--	--	<2.0	--	**6.0 J,B**	--	--
Alkalinity, Hydroxide (as $CaCO_3$)	--	--	--	--	--	--	--	--	--	<2.0	--	<2.0	--	--
Alkalinity, Total (as $CaCO_3$)	--	--	--	--	--	--	--	--	--	**261**	--	**173**	**185**	--
Calcium	98.1	--	**126**	--	**118**	--	**118**	--	**86.9 J,K,B**	--	**60.2 J,K,B**	--	**59.7**	--
Chloride (as Cl)	--	--	**2.6**	--	--	--	--	--	**10.4**	--	**5.3**	--	**6.43**	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as $CaCO_3$)	--	--	--	--	**442**	--	**429**	--	**268**	--	**183**	--	**187**	--
Magnesium	20.2	--	**37.6**	--	**35.6 J**	--	**32.9**	--	**12.4 J,K,B**	--	**7.8 J,K,B**	--	**9.14**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	--	--	**0.1 J,B**	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	<0.02	--	--	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	--	--	--	--	**0.08 J**	--	--	--	--	--
Potassium	3	--	--	--	--	--	--	--	**1.8 J,K,B**	--	**0.9 J,K,B**	--	**0.813 F**	--
Sodium	--	--	--	--	--	--	--	--	**10.1 J,K,B**	--	**6.4 J,K,B**	--	**8.15**	--
Sulfate (as SO_4)	--	--	**117**	--	**113 D**	--	**128 D**	--	**15.6**	--	**16.2**	--	**21.3**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	--	--	**8.0 J,B**	--	--	--	<2.5
Total dissolved solids (Residue, filterable)	--	--	--	**658**	--	**490**	--	**450**	**310**	--	--	--	--	**286**
Total organic carbon	--	--	--	--	--	--	--	--	--	**3.0 J,B**	--	--	--	--

TABLE B-6a

SUMMARY OF SURFACE (UPSTREAM) WATER RESULTS - HENRY SITE
P4 RI/FS
(Page 4 of 10)

Analyte/Methods (Units)	Location Identification		MSP014		MSP014		MSP014 Duplicate		MSP014 Triplicate		MSP014 Average		MSP014	
	Location Type		Pond		Pond		Pond		Pond		Pond		Pond	
	Date Collected		5/15/2004		5/4/2006		5/4/2006		5/4/2006		5/4/2006		9/18/2008	
	Background mg/l	Screening[a] mg/l	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Metals (mg/l)														
Aluminum	0.272	0.087	--	--	**0.04 J,K,B**	--	<0.03 K	--	<0.03 K	--	**0.04 K**	--	**0.905**	<0.05
Antimony	--	0.0056	--	--	<0.0004 K	--	<0.0004 K	--	<0.0004 K	--	<0.0004 K	--	--	--
Arsenic	0.00109	0.0062	--	--	**0.0012 J,K,B**	--	**0.0011 J,K,B**	--	**0.0012 J,K,B**	--	**0.00117 J,K,B**	--	--	--
Barium	0.0953	--	--	--	**0.028 J,K,B**	--	**0.028 J,K,B**	--	**0.029 J,K,B**	--	**0.0283 J,K,B**	--	--	--
Beryllium	0.002	--	--	--	<0.002 K	--	<0.002 K	--	<0.002 K	--	<0.002 K	--	--	--
Boron	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.0001	0.0013	**0.0002 J,K,B**	--	**0.0001 J,K,B**	--	**0.0002 J,K,B**	--	**0.0002 J,K,B**	--	**0.00017 J,K,B**	--	<0.000125	<0.000125
Chromium, Total	0.00284	0.011	--	--	**0.0003 J,K,B**	--	**0.0003 J,K,B**	--	**0.0003 J,K,B**	--	**0.0003 J,K,B**	--	**0.00253 B**	**0.00258 B**
Cobalt	0.01	--	--	--	<0.01 K	--	<0.01 K	--	<0.01 K	--	<0.01 K	--	--	--
Copper	0.01	0.037	--	--	<0.01 K	--	<0.01 K	--	<0.01 K	--	<0.01 K	--	--	--
Iron	0.112	0.3	--	--	<0.02 K	--	<0.02 K	--	<0.02 K	--	<0.02 K	--	**0.877**	<0.025
Lead	--	0.011	--	--	<0.0001 K	--	<0.0001 K	--	<0.0001 K	--	<0.0001 K	--	--	--
Manganese	0.0552	0.05	--	--	**0.508 J,K,B**	--	**0.515 J,K,B**	--	**0.456 J,K,B**	--	**0.493 J,K,B**	--	**0.0274**	**0.0589**
Mercury	--	0.00077	--	--	<0.0002	--	<0.0002	--	<0.0002	--	<0.0002	--	--	--
Molybdenum	0.01	--	--	--	<0.01 K	--	<0.01 K	--	<0.01 K	--	<0.01 K	--	--	--
Nickel	0.0027	0.17	**0.0108 J,K,B**	--	**0.0069 J,K,B**	--	**0.0065 J,K,B**	--	**0.007 J,K,B**	--	**0.0068 J,K,B**	--	**0.00771**	**0.00725**
Selenium	0.000772	0.0031/0.0015[b]	--	**0.035**	--	**0.077**	--	**0.075**	--	**0.069**	--	**0.0737**	**0.00813**	**0.00738**
Silver	0.01	0.037	--	--	<0.01 UJ,K	--	<0.01 UJ,K	--	<0.01 UJ,K	--	<0.01 UJ,K	--	--	--
Thallium	0.00015	0.00024	--	--	<0.0001 K	--	<0.0001 K	--	<0.0001 K	--	<0.0001 K	--	--	--
Uranium	0.00118	--	--	--	**0.005 J,K,B**	--	**0.005 J,K,B**	--	**0.0048 J,K,B**	--	**0.00493 J,K,B**	--	--	--
Vanadium	0.00491	--	**0.00277 J,K,B**	--	**0.0022 B,K**	--	**0.0021 B,K**	--	**0.0023 J,K,B**	--	**0.0022 J,K,B**	--	<0.005	<0.005
Zinc	0.0147	0.38	**0.004 J,K,B**	--	**0.017 J,K,B**	--	**0.009 J,K,B**	--	**0.009 J,K,B**	--	**0.0117 J,K,B**	--	<0.005	<0.005
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	**92**	--	**173**	--	**200**	--	**202**	--	**191.7**	--	--
Alkalinity, Carbonate	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	--
Alkalinity, Hydroxide (as $CaCO_3$)	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	--
Alkalinity, Total (as $CaCO_3$)	--	--	--	**92**	--	**173**	--	**200**	--	**202**	--	**191.7**	**107 J**	--
Calcium	98.1	--	**190 J,K,B**	--	**113 J,K,B**	--	**112 J,K,B**	--	**113 J,K,B**	--	**112.7 J,K,B**	--	**147**	--
Chloride (as Cl)	--	--	**3.2**	--	**4.1**	--	**4.1**	--	**4.1**	--	**4.1**	--	**7.91**	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as $CaCO_3$)	--	--	--	--	**432**	--	**428**	--	**431**	--	**430.3**	--	**488**	--
Magnesium	20.2	--	**51.5 J,K,B**	--	**36.3 J,K,B**	--	**36.1 J,K,B**	--	**36.2 J,K,B**	--	**36.2 J,K,B**	--	**29**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	**0.6**	--	**0.7**	--	**0.7**	--	**0.67**	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	3	--	**9.3 J,K,B**	--	**4.7 J,K,B**	--	**4.7 J,K,B**	--	**4.9 J,K,B**	--	**4.77 J,K,B**	--	**1.83**	--
Sodium	--	--	**10.5 J,K,B**	--	**7.6 J,K,B**	--	**7.5 J,K,B**	--	**7.6 J,K,B**	--	**7.57 J,K,B**	--	**9.06**	--
Sulfate (as SO_4)	--	--	**560**	--	**237**	--	**240**	--	**244**	--	**240.3**	--	**418**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	**10 J,B**	--	**10 J,B**	--	**6.0 J,B**	--	**8.7 J,B**	--	<2.5
Total dissolved solids (Residue, filterable)	--	--	--	--	**550**	--	**560**	--	**580**	--	**563.3**	--	--	**238**
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-6a

SUMMARY OF SURFACE (UPSTREAM) WATER RESULTS - HENRY SITE
P4 RI/FS

Analyte/Methods (Units)		Location Identification / Location Type / Date Collected	MSP014 Pond 9/29/2010		MSP015 Pond 5/18/2004		MSP015 Pond 5/4/2006		MSP015 Pond 9/30/2010		MSP016 Pond 5/17/2004		MSP016 Duplicate Pond 5/17/2004	
Metals (mg/l)	**Background mg/l**	**Screening[a] mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	0.272	0.087	--	--	--	--	<0.03 K	--	--	--	--	--	--	--
Antimony	--	0.0056	<0.003	--	--	--	<0.0004 K	--	<0.003	--	--	--	--	--
Arsenic	0.00109	0.0062	**0.00248**	--	--	--	<0.0005 K	--	**0.00257**	--	--	--	--	--
Barium	0.0953	--	--	--	--	--	**0.034 J,K,B**	--	--	--	--	--	--	--
Beryllium	0.002	--	--	--	--	--	<0.002 K	--	--	--	--	--	--	--
Boron	0.02	--	**0.028**	--	--	--	--	--	**0.0402**	--	--	--	--	--
Cadmium	0.0001	0.0013	**0.000018 J**	--	<0.0001 K	--	**0.0007 J,K,B**	--	**0.000077**	--	<0.0001 K	--	--	--
Chromium, Total	0.00284	0.011	**0.00078**	--	--	--	**0.0005 J,K,B**	--	**0.00051**	--	--	--	--	--
Cobalt	0.01	--	**0.00218**	--	--	--	<0.01 K	--	**0.00271**	--	--	--	--	--
Copper	0.01	0.037	**0.00068**	--	--	--	<0.01 K	--	**0.00177**	--	--	--	--	--
Iron	0.112	0.3	--	--	--	--	<0.02 K	--	--	--	--	--	--	--
Lead	--	0.011	--	--	--	--	<0.0001 K	--	--	--	--	--	--	--
Manganese	0.0552	0.05	**0.0204**	--	--	--	**0.0264 J,K,B**	--	**2.44**	--	--	--	--	--
Mercury	--	0.00077	<0.00002	--	--	--	<0.0002	--	<0.00002	--	--	--	--	--
Molybdenum	0.01	--	**0.0037**	--	--	--	<0.01 K	--	**0.0061**	--	--	--	--	--
Nickel	0.0027	0.17	**0.0048**	--	**0.0035 J,K,B**	--	**0.0138 J,K,B**	--	**0.0168**	--	**0.0038 J,K,B**	--	**0.0037 J-,K**	--
Selenium	0.000772	0.0031/0.0015[b]	**0.005**	**0.0053**	--	**0.153**	--	**0.38**	**0.0176**	**0.0225**	--	**0.124**	--	**0.123 J-**
Silver	0.01	0.037	<0.000008	--	--	--	<0.01 UJ,K	--	<0.000008	--	--	--	--	--
Thallium	0.00015	0.00024	0.000008 UB	--	--	--	<0.0001 K	--	**0.000064**	--	--	--	--	--
Uranium	0.00118	--	**0.0022**	--	--	--	**0.0049 J,K,B**	--	**0.0011**	--	--	--	--	--
Vanadium	0.00491	--	**0.00185**	--	**0.00255 J,K,B**	--	**0.0029 J,K,B**	--	**0.00232**	--	**0.00453 J,K,B**	--	**0.00441 J-,K**	--
Zinc	0.0147	0.38	**0.0008 J**	--	**0.002 J,K,B**	--	**0.04 J,K,B**	--	**0.003**	--	<0.002 K	--	--	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	--	--	**239**	--	**231**	--	--	--	**181**	--	**181**
Alkalinity, Carbonate	--	--	--	--	--	<2.0	--	<2.0	--	--	--	<2.0	--	<2.0
Alkalinity, Hydroxide (as $CaCO_3$)	--	--	--	--	--	<2.0	--	<2.0	--	--	--	<2.0	--	<2.0
Alkalinity, Total (as $CaCO_3$)	--	--	--	--	--	**239**	--	**231**	--	--	--	**181**	--	**181**
Calcium	98.1	--	**76.8**	--	**138 J,K,B**	--	**169 J,K,B**	--	**106**	--	**96.1 J,K,B**	--	**97 J-,K**	--
Chloride (as Cl)	--	--	--	--	**4.1**	--	**4.3**	--	--	--	**4.3**	--	**4.3**	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as $CaCO_3$)	--	--	**449**	--	--	--	**627**	--	**498**	--	--	--	--	--
Magnesium	20.2	--	**62.6**	--	**37.9 J,K,B**	--	**49.8 J,K,B**	--	**57.1**	--	**30.4 J,K,B**	--	**31.3 J-,K**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	**0.4 J,B**	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	3	--	--	--	**1.7 J,K,B**	--	**1.6 J,K,B**	--	--	--	**2.4 J,K,B**	--	**2.6 J-,K**	--
Sodium	--	--	--	--	**8.5 J,K,B**	--	**8.3 J,K,B**	--	--	--	**7.7 J,K,B**	--	**7.9 J-,K**	--
Sulfate (as SO_4)	--	--	--	--	**232**	--	**392**	--	--	--	**165**	--	**165**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	**8.0 J,B**	--	--	--	--	--	--
Total dissolved solids (Residue, filterable)	--	--	--	--	--	--	**810**	--	--	--	--	--	--	--
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-6a

SUMMARY OF SURFACE (UPSTREAM) WATER RESULTS - HENRY SITE
P4 RI/FS
(Page 6 of 10)

Analyte/Methods (Units)		Location Identification / Location Type / Date Collected	MSP016 Triplicate Pond 5/17/2004		MSP016 Average Pond 5/17/2004		MSP016 Pond 5/4/2006		MSP016 Pond 9/30/2010		MSP055 Pond 5/15/2004		MSP055 Pond 5/9/2006	
Metals (mg/l)	**Background mg/l**	**Screening[a] mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	0.272	0.087	--	--	--	--	<0.03 K	--	--	--	--	--	<0.03 K	--
Antimony	--	0.0056	--	--	--	--	<0.0004 K	--	<0.003	--	--	--	**0.0008 J,K,B**	--
Arsenic	0.00109	0.0062	--	--	--	--	<0.0005 K	--	**0.00253**	**0.0029**	--	--	0.0013 UB,K	--
Barium	0.0953	--	--	--	--	--	**0.038 J,K,B**	--	--	--	--	--	**0.006 J,K,B**	--
Beryllium	0.002	--	--	--	--	--	<0.002 K	--	--	--	--	--	<0.002 K	--
Boron	0.02	--	--	--	--	--	--	--	0.0084 UB	--	--	--	--	--
Cadmium	0.0001	0.0013	<0.0001 K	--	<0.0001 K	--	<0.0001 K	--	**0.000027**	**0.00128**	**0.0303 J,K,B**	--	**0.0203 J,K,B**	--
Chromium, Total	0.00284	0.011	--	--	--	--	**0.0005 J,K,B**	--	**0.00053**	**0.00414**	--	--	**0.0076 J,K,B**	--
Cobalt	0.01	--	--	--	--	--	<0.01 K	--	**0.00303**	**0.000372**	--	--	<0.01 K	--
Copper	0.01	0.037	--	--	--	--	<0.01 K	--	**0.0007**	**0.00303**	--	--	<0.01 K	--
Iron	0.112	0.3	--	--	--	--	<0.02 K	--	--	--	--	--	<0.02 K	--
Lead	--	0.011	--	--	--	--	<0.0001 K	--	--	--	--	--	<0.0001 K	--
Manganese	0.0552	0.05	--	--	--	--	**0.006 J,K,B**	--	**0.106**	--	--	--	<0.0005 K	--
Mercury	--	0.00077	--	--	--	--	<0.0002	--	<0.00002	--	--	--	<0.0002	--
Molybdenum	0.01	--	--	--	--	--	<0.01 K	--	**0.0042**	--	--	--	**0.04 J,K,B**	--
Nickel	0.0027	0.17	**0.0037 J,K,B**	--	**0.00373 J,K,B**	--	**0.0116 J,K,B**	--	**0.0062**	**0.0108**	**0.565 J,K,B**	--	**0.434 J,K,B**	--
Selenium	0.000772	0.0031/0.0015[b]	--	**0.125**	--	**0.124**	--	**0.41**	--	**0.0105**	--	**0.97**	--	**0.34**
Silver	0.01	0.037	--	--	--	--	<0.01 UJ,K	--	0.000006 UB	**0.000062**	--	--	<0.01 K	--
Thallium	0.00015	0.00024	--	--	--	--	<0.0001 K	--	0.000002 UB	**0.000098**	--	--	**0.0002 J,K,B**	--
Uranium	0.00118	--	--	--	--	--	**0.0043 J,K,B**	--	**0.0014**	**0.00203**	--	--	**0.0015 J,K,B**	--
Vanadium	0.00491	--	**0.00464 J,K,B**	--	**0.004527 J,K,B**	--	**0.0031 J,K,B**	--	**0.00862**	**0.0121**	**0.0376 J,K,B**	--	**0.0689 J,K,B**	--
Zinc	0.0147	0.38	<0.002 K	--	<0.002 K	--	**0.014 J,K,B**	--	**0.0012 J**	--	**1.9 J,K,B**	--	<0.01 K	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	**181**	--	**181**	--	**185**	--	--	--	**85**	--	**120**
Alkalinity, Carbonate	--	--	--	<2.0	--	<2.0	--	<2.0	--	--	--	<2.0	--	<2.0
Alkalinity, Hydroxide (as $CaCO_3$)	--	--	--	<2.0	--	<2.0	--	<2.0	--	--	--	<2.0	--	<2.0
Alkalinity, Total (as $CaCO_3$)	--	--	--	**181**	--	**181**	--	**185**	--	--	--	**85**	--	**120**
Calcium	98.1	--	**96 J,K,B**	--	**96.37 J,K,B**	--	**140 J,K,B**	--	**64.3**	--	**181 J,K,B**	--	**93.6 J,K,B**	--
Chloride (as Cl)	--	--	**4.2**	--	**4.27**	--	**3.9**	--	--	--	**1.5 J,B**	--	<0.5	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as $CaCO_3$)	--	--	--	--	--	--	**536**	--	**323**	--	--	--	**338**	--
Magnesium	20.2	--	**30.4 J,K,B**	--	**30.7 J,K,B**	--	**45.2 J,K,B**	--	**39.5**	--	**45.1 J,K,B**	--	**25.3 J,K,B**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	**0.5**	--	--	--	--	--	<0.1
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	3	--	**2.4 J,K,B**	--	**2.47 J,K,B**	--	**1.8 J,K,B**	--	--	--	**1.0 J,K,B**	--	**0.6 J,K,B**	--
Sodium	--	--	**7.7 J,K,B**	--	**7.77 J,K,B**	--	**7.9 J,K,B**	--	--	--	**2.9 J,K,B**	--	**1.4 J,K,B**	--
Sulfate (as SO_4)	--	--	**164**	--	**164.7**	--	**333**	--	--	--	**510**	--	**277**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	**10 J,B**	--	--	--	--	--	<5.0
Total dissolved solids (Residue, filterable)	--	--	--	--	--	--	**690**	--	--	--	--	--	**460**	--
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-6a

SUMMARY OF SURFACE (UPSTREAM) WATER RESULTS - HENRY SITE
P4 RI/FS
(Page 7 of 10)

Analyte/Methods (Units)	Location Identification / Location Type / Date Collected		MSP055 Pond 5/10/2007		MSP055 Pond 5/15/2008		MST052 Stream 5/9/2006		MST063 Stream 5/18/2004		MST063 Stream 5/4/2006	MST063 Duplicate Stream 5/4/2006	MST063 Triplicate Stream 5/4/2006
Metals (mg/l)	Background mg/l	Screening[a] mg/l	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Total	Total	Total
Aluminum	0.272	0.087	--	<0.03 K	<0.03 K	0.11 J,K,B	<0.03 K	--	--	--	--	--	--
Antimony	--	0.0056	--	--	0.0005 J,K,B	0.0006 J,K,B	<0.0004 K	--	--	--	--	--	--
Arsenic	0.00109	0.0062	--	--	0.0129 J,K,B	0.0161 J,K,B	0.0011 UB,K	--	--	--	--	--	--
Barium	0.0953	--	--	--	0.008 J,K,B	0.007 J,K,B	0.04 J,K,B	--	--	--	--	--	--
Beryllium	0.002	--	--	--	<0.002 K	<0.002 K	<0.002 K	--	--	--	--	--	--
Boron	0.02	--	--	--	<0.01 K	<0.01 K	--	--	--	--	--	--	--
Cadmium	0.0001	0.0013	0.0352 J,K	--	0.0176 J,K,B	0.0194 J,K,B	0.0002 J,K,B	--	<0.0001 K	--	--	--	--
Chromium, Total	0.00284	0.011	0.0057 J,K	--	0.0076 J,K,B	0.0151 J,K,B	0.0004 J,K,B	--	--	--	--	--	--
Cobalt	0.01	--	--	--	<0.01 K	<0.01 K	<0.01 K	--	--	--	--	--	--
Copper	0.01	0.037	--	--	<0.01 K	0.01 J,K,B	<0.01 K	--	--	--	--	--	--
Iron	0.112	0.3	--	--	<0.02 K	0.06 J,K,B	<0.02 K	--	--	--	--	--	--
Lead	--	0.011	--	--	<0.0001 K	0.0002 J,K,B	<0.0001 K	--	--	--	--	--	--
Manganese	0.0552	0.05	--	--	<0.0005 K	0.0032 J,K,B	0.0071 J,K,B	--	--	--	--	--	--
Mercury	--	0.00077	--	--	<0.0002	<0.0002	<0.0002	--	--	--	--	--	--
Molybdenum	0.01	--	--	--	0.03 J,K,B	0.03 J,K,B	<0.01 K	--	--	--	--	--	--
Nickel	0.0027	0.17	1.26 J,K,B	--	0.344 J,K,B	0.397 J,K,B	0.0027 J,K,B	--	0.0019 J,K,B	--	--	--	--
Selenium	0.000772	0.0031/0.0015[b]	--	0.36	0.53	0.53	--	0.001 J,B	--	0.002 J,B	0.006	0.006	0.007
Silver	0.01	0.037	--	--	<0.01 UJ,K	<0.01 K	<0.01 K	--	--	--	--	--	--
Thallium	0.00015	0.00024	--	--	0.0002 J,K,B	0.0005 UB,K	<0.0001 K	--	--	--	--	--	--
Uranium	0.00118	--	0.0024 J,K	--	0.0012 J,K,B	0.0016 J,K,B	0.0007 J,K,B	--	--	--	--	--	--
Vanadium	0.00491	--	0.0281 J,K	--	0.0367 J,K,B	0.0508 J,K,B	0.0027 J,K,B	--	0.001 J,K,B	--	--	--	--
Zinc	0.0147	0.38	4.73 J,K,B	--	1.79 J,K,B	1.71 J,K,B	0.008 J,K,B	--	<0.002 K	--	--	--	--
Chemistry Parameters (mg/l)													
Alkalinity, Bicarbonate	--	--	--	126	--	52	--	184	--	267	--	--	--
Alkalinity, Carbonate	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	--	--
Alkalinity, Hydroxide (as $CaCO_3$)	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	--	--
Alkalinity, Total (as $CaCO_3$)	--	--	--	126	--	52	--	184	--	267	--	--	--
Calcium	98.1	--	232 J,K,B	--	90.3 J,K,B	95.5 J,K,B	34.2 J,K,B	--	94.3 J,K,B	--	--	--	--
Chloride (as Cl)	--	--	1.3 J-,B	--	1.2 J,B	--	1.6 J,B	--	8.0	--	--	--	--
Fluoride	--	--	--	--	0.7	--	--	--	--	--	--	--	--
Hardness (as $CaCO_3$)	--	--	827	--	321	335	125	--	--	--	--	--	--
Magnesium	20.2	--	60.1 J,K,B	--	23.2 J,K,B	23.4 J,K,B	9.7 J,K,B	--	25.5 J,K,B	--	--	--	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	0.4 J-,B	--	0.5	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	0.47	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	0.02 J-,B	--	--	--	--	--	--	--	--
Potassium	3	--	0.8 J,K,B	--	0.6 J,K,B	0.5 J,K,B	1.2 J,K,B	--	1.1 J,K,B	--	--	--	--
Sodium	--	--	4.6 J,K,B	--	1.8 J,K,B	1.9 J,K,B	3.8 J,K,B	--	12.9 J,K,B	--	--	--	--
Sulfate (as SO_4)	--	--	750 J-	--	256	--	4.8	--	54.1	--	--	--	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	54	--	92	--	--	--	--	--
Total dissolved solids (Residue, filterable)	--	--	--	--	420 J-	--	140	--	--	--	--	--	--
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-6a

SUMMARY OF SURFACE (UPSTREAM) WATER RESULTS - HENRY SITE
P4 RI/FS
(Page 8 of 10)

Analyte/Methods (Units)		Location Identification / Location Type / Date Collected	MST063 Average Stream 5/4/2006	MST063 Stream 5/5/2006		MST063 Duplicate Stream 5/5/2006		MST063 Triplicate Stream 5/5/2006		MST063 Average Stream 5/5/2006		MST063 Stream 5/3/2007	
Metals (mg/l)	**Background mg/l**	**Screening[a] mg/l**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	0.272	0.087	--	<0.03 K	--	<0.03 K	--	<0.03 K	--	<0.03 K	--	--	**0.1 J-,B,K**
Antimony	--	0.0056	--	<0.0004 K	--	<0.0004 K	--	<0.0004 K	--	<0.0004 K	--	--	--
Arsenic	0.00109	0.0062	--	<0.0005 K	--	<0.0005 K	--	<0.0005 K	--	<0.0005 K	--	--	--
Barium	0.0953	--	--	**0.038 J,K,B**	--	**0.037 J,K,B**	--	**0.037 J,K,B**	--	**0.0373 J,K,B**	--	--	--
Beryllium	0.002	--	--	<0.002 K	--	<0.002 K	--	<0.002 K	--	<0.002 K	--	--	--
Boron	0.02	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.0001	0.0013	--	<0.0001 K	--	<0.0001 K	--	<0.0001 K	--	<0.0001 K	--	<0.0001 K	--
Chromium, Total	0.00284	0.011	--	**0.0004 J,K,B**	--	**0.0003 J,K,B**	--	**0.0003 J,K,B**	--	**0.00033 J,K,B**	--	<0.0001 K	--
Cobalt	0.01	--	--	<0.01 K	--	<0.01 K	--	<0.01 K	--	<0.01 K	--	--	--
Copper	0.01	0.037	--	<0.01 K	--	<0.01 K	--	<0.01 K	--	<0.01 K	--	--	--
Iron	0.112	0.3	--	<0.02 K	--	<0.02 K	--	<0.02 K	--	<0.02 K	--	--	--
Lead	--	0.011	--	**0.0005 J,K,B**	--	**0.0004 J,K,B**	--	**0.0004 J,K,B**	--	**0.00043 J,K,B**	--	--	--
Manganese	0.0552	0.05	--	**0.0405 J,K,B**	--	**0.0424 J,K,B**	--	**0.0423 J,K,B**	--	**0.04173 J,K,B**	--	--	--
Mercury	--	0.00077	--	<0.0002	--	<0.0002	--	<0.0002	--	<0.0002	--	--	--
Molybdenum	0.01	--	--	<0.01 K	--	<0.01 K	--	<0.01 K	--	<0.01 K	--	--	--
Nickel	0.0027	0.17	--	**0.0007 J,K,B**	--	**0.0006 J,K,B**	--	**0.0006 J,K,B**	--	**0.00063 J,K,B**	--	**0.0031 J,K,B**	--
Selenium	0.000772	0.0031/0.0015[b]	**0.0063**	--	**0.006**	--	**0.006**	--	**0.006**	--	**0.006**	--	**0.005 J,B**
Silver	0.01	0.037	--	<0.01 UJ,K	--	<0.01 UJ,K	--	<0.01 UJ,K	--	<0.01 UJ,K	--	--	--
Thallium	0.00015	0.00024	--	<0.0001 K	--	<0.0001 K	--	<0.0001 K	--	<0.0001 K	--	--	--
Uranium	0.00118	--	--	**0.0017 J,K,B**	--	**0.0017 J,K,B**	--	**0.0016 J,K,B**	--	**0.00167 J,K,B**	--	**0.0024 J,K,B**	--
Vanadium	0.00491	--	--	<0.0002 K	--	<0.0002 K	--	<0.0002 K	--	<0.0002 K	--	**0.0011 B,K**	--
Zinc	0.0147	0.38	--	**0.018 J,K,B**	--	**0.002 J,K,B**	--	<0.002 K	--	**0.01 J,K**	--	**0.002 J,K,B**	--
Chemistry Parameters (mg/l)													
Alkalinity, Bicarbonate	--	--	--	--	**279**	--	**288**	--	**261**	--	**276**	--	**274**
Alkalinity, Carbonate	--	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0
Alkalinity, Hydroxide (as $CaCO_3$)	--	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0
Alkalinity, Total (as $CaCO_3$)	--	--	--	--	**279**	--	**288**	--	**261**	--	**276**	--	**274**
Calcium	98.1	--	--	**62.1 J,K,B**	--	**62.7 J,K,B**	--	**61.8 J,K,B**	--	**62.2 J,K,B**	--	**96.4 J,K,B**	--
Chloride (as Cl)	--	--	--	**10.2**	--	**10.2**	--	**10.2**	--	**10.2**	--	**11.5**	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as $CaCO_3$)	--	--	--	**198**	--	**199**	--	**197**	--	**198**	--	**309**	--
Magnesium	20.2	--	--	**10.3 J,K,B**	--	**10.4 J,K,B**	--	**10.3 J,K,B**	--	**10.33 J,K,B**	--	**16.5 J,K,B**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	**0.2 J,B**	--	**0.3 J,B**	--	**0.2 J,B**	--	**0.23 J,B**	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	3	--	--	**0.7 J,K,B**	--	**0.8 J,K,B**	--	**0.7 J,K,B**	--	**0.73 J,K,B**	--	**0.8 J,K,B**	--
Sodium	--	--	--	**8.9 J,K,B**	--	**8.9 J,K,B**	--	**8.9 J,K,B**	--	**8.9 J,K,B**	--	**10.4 J,K,B**	--
Sulfate (as SO_4)	--	--	--	**17.7**	--	**17.7**	--	**17.7**	--	**17.7**	--	**41.8**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	<5.0	--	<5.0	--	<5.0	--	<5.0	--	--
Total dissolved solids (Residue, filterable)	--	--	--	**240**	--	**240**	--	**240**	--	**240**	--	--	--
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-6a

SUMMARY OF SURFACE (UPSTREAM) WATER RESULTS - HENRY SITE
P4 RI/FS

Analyte/Methods (Units)		Location Identification Location Type Date Collected	MST063 Stream 5/5/2009		MST063 Stream 5/15/2010		MST063 Stream 5/9/2012		MST063 Stream 4/23/2013		MST063 Stream 5/7/2014		MST280 Stream 5/22/2008	
Metals (mg/l)	**Background mg/l**	**Screening[a] mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	0.272	0.087	--	--	--	--	--	--	--	--	--	--	--	**0.06 J-,B,K**
Antimony	--	0.0056	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.00109	0.0062	--	--	--	--	--	--	--	--	--	--	--	--
Barium	0.0953	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	0.002	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.0001	0.0013	<0.000125	--	<0.0003	--	**0.00373 D**	--	<0.0003	--	<0.0003	--	**0.0078 J,K,B**	--
Chromium, Total	0.00284	0.011	--	--	--	--	--	--	--	--	--	--	**0.0007 J,K,B**	--
Cobalt	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	0.01	0.037	--	--	--	--	--	--	--	--	--	--	--	--
Iron	0.112	0.3	<0.025	--	<0.025	--	--	--	--	--	--	--	--	--
Lead	--	0.011	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	0.0552	0.05	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	0.00077	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	0.0027	0.17	--	--	--	--	--	--	--	--	--	--	**0.0646 J,K,B**	--
Selenium	0.000772	0.0031/0.0015[b]	--	**0.0058 J**	--	**0.00234**	--	**0.0052 J+**	**0.0152**	**0.0181**	**0.0123**	**0.0112**	--	**0.29**
Silver	0.01	0.037	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.00015	0.00024	--	--	--	--	--	--	--	--	--	--	--	--
Uranium	0.00118	--	--	--	--	--	--	--	--	--	--	--	**0.0134 J,K,B**	--
Vanadium	0.00491	--	<0.005	--	<0.005	--	<0.005	--	<0.005	--	<0.005	--	**0.0402 J,K,B**	--
Zinc	0.0147	0.38	--	--	--	--	--	--	--	--	--	--	**0.142 J,K,B**	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	--	--	--	--	--	--	--	--	--	--	**178**
Alkalinity, Carbonate	--	--	--	--	--	--	--	--	--	--	--	--	--	**21**
Alkalinity, Hydroxide (as $CaCO_3$)	--	--	--	--	--	--	--	--	--	--	--	--	--	<2.0
Alkalinity, Total (as $CaCO_3$)	--	--	--	--	--	--	--	--	--	--	--	--	--	**199**
Calcium	98.1	--	**70.7**	--	**90**	--	**83.6**	--	**86.7**	--	**84.8**	--	**140 J,K,B**	--
Chloride (as Cl)	--	--	**10.3**	--	**7.66**	--	--	--	--	--	--	--	**1.8 J,B**	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as $CaCO_3$)	--	--	**239**	--	**287**	--	**324**	--	**288**	--	**275**	--	**485**	--
Magnesium	20.2	--	**15.2**	--	**15.7**	--	**28**	--	**17.3 J**	--	**15.4**	--	**32.8 J,K,B**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	3	--	--	--	--	--	--	--	--	--	--	--	**1.2 J,K,B**	--
Sodium	--	--	--	--	--	--	--	--	--	--	--	--	**5.5 J,K,B**	--
Sulfate (as SO_4)	--	--	**31.8**	--	**35.9**	--	**49.3 J+**	--	**45.8**	--	**38**	--	**244**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total dissolved solids (Residue, filterable)	--	--	--	**300**	--	**356**	--	**404**	--	**440**	--	**348**	--	--
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-6a

SUMMARY OF SURFACE (UPSTREAM) WATER RESULTS - HENRY SITE
P4 RI/FS

Footnotes:

a The State of Idaho surface water quality criteria and the USEPA NRWQC values for metals with hardness-dependent toxicity (i.e., cadmium, chromium, copper, lead, nickel, silver, and zinc) were adjusted for the Site-specific hardness concentrations measured in upstream, downstream, and pond surface water locations. Hardness at upstream and pond locations exceeded 400 mg/L, so a maximum allowable water hardness of 400 mg/L was used to adjust surface water quality criteria for downstream and pond locations.

b The 2016 NRWQC chronic aquatic life criteria for selenium are 0.0031 mg/l for lotic stations (seep - MDS, spring - MSG, stream - MST) and 0.0015 mg/L for lentic stations (pond - MSP).

mg/l	milligrams per liter.
Bold	Bolded result indicates positively identified compound.
--	Not scheduled.
	Blue shaded result indicates both screening limit and background limit exceeded.
	Yellow shaded result indicates non-detected result greater than background and screening level.
B	Analyte detected in an associated blank.
D	Sample dilution required for analysis; reported values reflect the dilution.
F	Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J	Data are estimated due to associated quality control data. Bias unknown.
J-	Data are estimated due to associated quality control data. Potential low bias.
J+	Data are estimated due to associated quality control data. Potential high bias.
K	Serial dilutions not analyzed for these methods (EPA 200.7 and 200.8).
UB	Analyte considered not detected based on associated blank data.
UJ	Potential low bias, possible false negative.

TABLE B-6b

SUMMARY OF SURFACE WATER (DOWNSTREAM) RESULTS - HENRY SITE
P4 RI/FS
(Page 1 of 22)

		Location Identification	MST043		MST043 Duplicate		MST043 Triplicate		MST043 Average		MST044		MST044	
		Location Type	Stream		Stream		Stream		Stream		Stream		Stream	
Analyte/Methods (Units)		Date Collected	5/21/2004		5/21/2004		5/21/2004		5/21/2004		5/19/2004		5/9/2007	
Metals (mg/l)	**Background mg/l**	**Screening [a] mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	0.272	0.087	--	--	--	--	--	--	--	--	--	--	--	**0.11 J,K,B**
Antimony	--	0.0056	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.00109	0.0062	--	--	--	--	--	--	--	--	--	--	--	--
Barium	0.0953	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	0.002	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.0001	0.00098	<0.0002 K	--	<0.0001 UJ,K	--	<0.0001 UJ,K	--	<0.0002 UJ,K	--	<0.0001 K	--	<0.0001 K	--
Chromium, Total	0.00284	0.011	--	--	--	--	--	--	--	--	--	--	**0.0002 J,K,B**	--
Cobalt	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	0.01	0.025	--	--	--	--	--	--	--	--	--	--	--	--
Iron	0.112	0.3	--	--	--	--	--	--	--	--	--	--	--	--
Lead	--	0.0069	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	0.055	0.05	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	0.00077	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	0.0027	0.12	**0.0015 J,K,B**	--	**0.0041 J,K**	--	**0.0038 J,K**	--	**0.00313 J,K**	--	**0.0008 J,K,B**	--	**0.0007 J,K,B**	--
Selenium	0.000772	0.0031	--	<0.001	--	<0.001	--	<0.001	--	<0.001	--	<0.001	--	<0.001
Silver	0.01	0.017	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.00015	0.00024	--	--	--	--	--	--	--	--	--	--	--	--
Uranium	0.00118	--	--	--	--	--	--	--	--	--	--	--	**0.0013 J,K,B**	--
Vanadium	0.00491	--	**0.0011 J,K,B**	--	**0.00117 J,K**	--	**0.00115 J,K**	--	**0.00114 J,K**	--	**0.0013 J,K,B**	--	**0.0015 J,K,B**	--
Zinc	0.0147	0.26	**0.004 J,K,B**	--	**0.004 J,K,B**	--	**0.004 J,K,B**	--	**0.004 J,K,B**	--	<0.002 K	--	<0.002 K	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	**492**	--	**460**	--	**291**	--	**414.3**	--	**177**	--	**181**
Alkalinity, Carbonate	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	**7.0 J,B**	--	**12 J,B**
Alkalinity, Hydroxide (as CaCO3)	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0
Alkalinity, Total (as CaCO3)	--	--	--	**492**	--	**460**	--	**291**	--	**414.3**	--	**184**	--	**193**
Calcium	98.1	--	**146 J,K,B**	--	**141 J,K,B**	--	**140 J,K,B**	--	**142.3 J,K,B**	--	**70 J,K,B**	--	**72.6 J,K,B**	--
Chloride (as Cl)	--	--	**17.8**	--	**18.2**	--	**17.8**	--	**17.93**	--	**2.1 J,B**	--	**51.6**	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--	--	**285**	--
Magnesium	20.2	--	**41.2 J,K,B**	--	**40.3 J,K,B**	--	**40.1 J,K,B**	--	**40.53 J,K,B**	--	**26.7 J,K,B**	--	**25.3 J,K,B**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	3	--	**2.5 J,K,B**	--	**2.4 J,K,B**	--	**2.3 J,K,B**	--	**2.4 J,K,B**	--	**2.9 J,K,B**	--	**2.5 J,K,B**	--
Sulfate (as SO4)	--	--	**53.2**	--	**53.5**	--	**53.1**	--	**53.27**	--	**8.6 J**	--	**110 J-**	--
Sodium	--	--	**16.1 J,K,B**	--	**15.5 J,K,B**	--	**15.6 J,K,B**	--	**15.73 J,K,B**	--	**43.9 J,K,B**	--	**41.4 J,K,B**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total dissolved solids (Residue, filterable)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-6b

SUMMARY OF SURFACE WATER (DOWNSTREAM) RESULTS - HENRY SITE
P4 RI/FS
(Page 2 of 22)

Location Identification / Location Type / Date Collected			MST044 Duplicate Stream 5/9/2007		MST044 Triplicate Stream 5/9/2007		MST044 Average Stream 5/9/2007		MST044 Stream 9/9/2007		MST044 Stream 5/10/2008		MST044 Stream 9/17/2008	
Analyte/Methods (Units)	**Background mg/l**	**Screening [a] mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Metals (mg/l)														
Aluminum	0.272	0.087	--	**0.11 J,K,B**	--	**0.11 J,K,B**	--	**0.11 J,K,B**	--	**0.08 J,K,B**	--	0.08 UB,K	<0.05	--
Antimony	--	0.0056	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.00109	0.0062	--	--	--	--	--	--	--	--	--	--	--	--
Barium	0.0953	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	0.002	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.0001	0.00098	<0.0001 K	--	<0.0001 K	--	<0.0001 K	--	<0.0001 K	--	<0.0001 K	--	<0.000125	--
Chromium, Total	0.00284	0.011	**0.0002 J,K,B**	--	**0.0003 J,K,B**	--	**0.00023 J,K,B**	--	<0.0001 K	--	<0.0001 K	--	**0.00132 F**	--
Cobalt	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	0.01	0.025	--	--	--	--	--	--	--	--	--	--	--	--
Iron	0.112	0.3	--	--	--	--	--	--	--	--	--	--	<0.025	--
Lead	--	0.0069	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	0.055	0.05	--	--	--	--	--	--	--	--	--	--	**0.0035**	--
Mercury	--	0.00077	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	0.0027	0.12	**0.0008 J,K,B**	--	**0.0012 J,K,B**	--	**0.0009 J,K,B**	--	**0.0013 J,K,B**	--	**0.002 J,K,B**	--	**0.00202 F**	--
Selenium	0.000772	0.0031	--	<0.001	--	<0.001	--	<0.001	--	**0.046**	--	<0.001	--	0.000958 F,UB
Silver	0.01	0.017	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.00015	0.00024	--	--	--	--	--	--	--	--	--	--	--	--
Uranium	0.00118	--	**0.0013 J,K,B**	--	**0.0013 J,K,B**	--	**0.0013 J,K,B**	--	**0.0019 J,K,B**	--	**0.0011 J,K,B**	--	--	--
Vanadium	0.00491	--	**0.0015 J,K,B**	--	**0.0015 J,K,B**	--	**0.0015 J,K,B**	--	**0.002 J,K,B**	--	**0.0885 J,K,B**	--	<0.025	--
Zinc	0.0147	0.26	<0.002 K	--	**0.003 J,K,B**	--	**0.003 J,K,B**	--	**0.005 J,K,B**	--	**0.002 J,K,B**	--	<0.005 UJ	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	**181**	--	**184**	--	**182**	--	**138**	--	**162**	--	--
Alkalinity, Carbonate	--	--	--	**13 J,B**	--	**14 J,B**	--	**13 J,B**	--	**14 J,B**	--	**11 J,B**	--	--
Alkalinity, Hydroxide (as CaCO3)	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	--
Alkalinity, Total (as CaCO3)	--	--	--	**194**	--	**198**	--	**195**	--	**152**	--	**173**	**141**	--
Calcium	98.1	--	**72.5 J,K,B**	--	**73.8 J,K,B**	--	**72.97 J,K,B**	--	**66.9 J,K,B**	--	**69.1 J,K,B**	--	**65.8**	--
Chloride (as Cl)	--	--	**51.6**	--	**51.5**	--	**51.57**	--	**81.4**	--	**35.3**	--	**83.4**	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	**285**	--	**290**	--	**286.7**	--	**312**	--	**255**	--	**305**	--
Magnesium	20.2	--	**25.3 J,K,B**	--	**25.7 J,K,B**	--	**25.43 J,K,B**	--	**35.1 J,K,B**	--	**20.1 J,K,B**	--	**34.2**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	3	--	**2.6 J,K,B**	--	**2.6 J,K,B**	--	**2.57 J,K,B**	--	**3.5 J,K,B**	--	**2.6 J,K,B**	--	**3.6**	--
Sulfate (as SO4)	--	--	**108 J-**	--	**110 J-**	--	**109.3 J-**	--	**185**	--	**72.9**	--	**173**	--
Sodium	--	--	**41.5 J,K,B**	--	**41.5 J,K,B**	--	**41.47 J,K,B**	--	**68.4 J,K,B**	--	**28.7 J,K,B**	--	**66.1**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	--	--	--	--	--	--	<2.5
Total dissolved solids (Residue, filterable)	--	--	--	--	--	--	--	--	--	--	--	--	--	**556**
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-6b

SUMMARY OF SURFACE WATER (DOWNSTREAM) RESULTS - HENRY SITE
P4 RI/FS
(Page 3 of 22)

Location Identification			MST044 Duplicate		MST044 Triplicate		MST044 Average		MST044		MST044		MST044	
Location Type			Stream		Stream		Stream		Stream		Stream		Stream	
Date Collected			9/17/2008		9/17/2008		9/17/2008		5/5/2009		9/21/2009		5/14/2010	
Analyte/Methods (Units)														
Metals (mg/l)	**Background mg/l**	**Screening [a] mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	0.272	0.087	<0.05	--	<0.05	--	<0.05	--	--	--	--	--	--	--
Antimony	--	0.0056	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.00109	0.0062	--	--	--	--	--	--	--	--	--	--	--	--
Barium	0.0953	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	0.002	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.0001	0.00098	<0.000125	--	<0.000125	--	<0.000125	--	<0.000125	--	<0.000125	--	<0.0003	--
Chromium, Total	0.00284	0.011	**0.00114 F**	--	**0.00132 F**	--	**0.00126 F**	--	--	--	--	--	--	--
Cobalt	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	0.01	0.025	--	--	--	--	--	--	--	--	--	--	--	--
Iron	0.112	0.3	<0.025	--	<0.025	--	<0.025	--	<0.025	--	<0.025	--	<0.025	--
Lead	--	0.0069	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	0.055	0.05	**0.0138**	--	**0.0117**	--	**0.00967**	--	--	--	--	--	--	--
Mercury	--	0.00077	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	0.0027	0.12	**0.00262 F**	--	**0.00251 F**	--	**0.002383 F**	--	--	--	--	--	--	--
Selenium	0.000772	0.0031	--	**0.00123 B**	--	**0.00126**	--	0.001149 F,UB	--	**0.000801 F,B**	--	**0.00105**	--	**0.000901 J**
Silver	0.01	0.017	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.00015	0.00024	--	--	--	--	--	--	--	--	--	--	--	--
Uranium	0.00118	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	0.00491	--	<0.025	--	<0.025	--	<0.025	--	<0.005	--	**0.00828 J**	--	<0.005	--
Zinc	0.0147	0.26	<0.005 UJ	--	**0.01 F**	--	**0.01 F**	--	--	--	--	--	--	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Carbonate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Hydroxide (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Total (as CaCO3)	--	--	**150**	--	**140**	--	**143.7**	--	--	--	--	--	--	--
Calcium	98.1	--	**64.6**	--	**65.4**	--	**65.27**	--	**48.6**	--	**67.7**	--	**77.3**	--
Chloride (as Cl)	--	--	**83.8**	--	**83.8**	--	**83.67**	--	**13.6**	--	**63.8**	--	**35.9**	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	**306**	--	**307**	--	**306**	--	**169**	--	**283**	--	**285**	--
Magnesium	20.2	--	**35.1**	--	**34.9**	--	**34.73**	--	**11.6**	--	**27.8**	--	**22.3**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	3	--	**3.69**	--	**3.86**	--	**3.717**	--	--	--	--	--	--	--
Sulfate (as SO4)	--	--	**173**	--	**175**	--	**173.7**	--	**25.5**	--	**129**	--	**70.1**	--
Sodium	--	--	**66.2**	--	**67.4**	--	**66.57**	--	--	--	--	--	--	--
Suspended solids (Residue, non-filterable)	--	--	--	<2.5	--	<2.5	--	<2.5	--	--	--	--	--	--
Total dissolved solids (Residue, filterable)	--	--	--	**632**	--	**508**	--	**565.3**	--	**232**	--	**430**	--	**380**
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-6b

SUMMARY OF SURFACE WATER (DOWNSTREAM) RESULTS - HENRY SITE
P4 RI/FS
(Page 4 of 22)

Analyte/Methods (Units)		Location Identification	MST044		MST044		MST044		MST044 Duplicate		MST044 Average		MST044	
		Location Type	Stream		Stream		Stream		Stream		Stream		Stream	
		Date Collected	9/16/2010		5/9/2012		9/17/2012		9/17/2012		9/17/2012		4/24/2013	
Metals (mg/l)	**Background mg/l**	**Screening [a] mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	0.272	0.087	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	0.0056	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.00109	0.0062	--	--	--	--	--	--	--	--	--	--	--	--
Barium	0.0953	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	0.002	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.0001	0.00098	<0.0006 UJ	--	<0.0006 D	--	<0.0003	--	<0.0003	--	<0.0003	--	<0.0003	--
Chromium, Total	0.00284	0.011	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	0.01	0.025	--	--	--	--	--	--	--	--	--	--	--	--
Iron	0.112	0.3	**0.0367 B**	--	--	--	--	--	--	--	--	--	--	--
Lead	--	0.0069	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	0.055	0.05	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	0.00077	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	0.0027	0.12	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	0.000772	0.0031	--	<0.001	--	**0.00114 F,J+**	--	**0.00141**	--	**0.0013**	--	**0.001355**	**0.0011**	**0.00123**
Silver	0.01	0.017	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.00015	0.00024	--	--	--	--	--	--	--	--	--	--	--	--
Uranium	0.00118	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	0.00491	--	<0.005	--	<0.005	--	<0.005	--	<0.005	--	<0.005	--	<0.005	--
Zinc	0.0147	0.26	--	--	--	--	--	--	--	--	--	--	--	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Carbonate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Hydroxide (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Total (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	98.1	--	**66.8**	--	**65.5**	--	**65.3**	--	**65.1**	--	**65.2**	--	**66.6**	--
Chloride (as Cl)	--	--	**76.2**	--	--	--	--	--	--	--	--	--	--	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	**297**	--	**257**	--	**287**	--	**287**	--	**287**	--	**262**	--
Magnesium	20.2	--	**31.7**	--	**22.6**	--	**30.1**	--	**30.2**	--	**30.15**	--	**23.2 J**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	3	--	--	--	--	--	--	--	--	--	--	--	--	--
Sulfate (as SO4)	--	--	**155**	--	**110 J+**	--	**151 D**	--	**151 D**	--	**151 D**	--	**85.1 D**	--
Sodium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total dissolved solids (Residue, filterable)	--	--	--	**482**	--	**426**	--	**458**	--	**496**	--	**477**	--	**370**
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-6b

SUMMARY OF SURFACE WATER (DOWNSTREAM) RESULTS - HENRY SITE
P4 RI/FS
(Page 5 of 22)

Location Identification			MST044		MST044		MST044		MST045		MST045		MST045	
Location Type			Stream		Stream		Stream		Stream		Stream		Stream	
Date Collected			9/23/2013		5/9/2014		9/12/2014		5/19/2004		5/9/2007		9/9/2007	
Analyte/Methods (Units)														
Metals (mg/l)	**Background mg/l**	**Screening [a] mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	0.272	0.087	--	--	--	--	--	--	--	--	--	**0.14 J,K,B**	--	**0.03 J,K,B**
Antimony	--	0.0056	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.00109	0.0062	--	--	--	--	--	--	--	--	--	--	--	--
Barium	0.0953	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	0.002	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.0001	0.00098	<0.0003	--	<0.0003	--	<0.0003 X	--	<0.0001 K	--	<0.0001 K	--	<0.0001 K	--
Chromium, Total	0.00284	0.011	--	--	--	--	--	--	--	--	0.0004 UB,K	--	<0.0001 K	--
Cobalt	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	0.01	0.025	--	--	--	--	--	--	--	--	--	--	--	--
Iron	0.112	0.3	--	--	--	--	--	--	--	--	--	--	--	--
Lead	--	0.0069	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	0.055	0.05	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	0.00077	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	0.0027	0.12	--	--	--	--	--	--	**0.0005 J,K,B**	--	**0.0009 J,K,B**	--	**0.0013 J,K,B**	--
Selenium	0.000772	0.0031	**0.001 F**	**0.000844 F**	**0.00579 J+**	**0.000675 F**	**0.000894 F**	**0.00186**	--	<0.001	--	<0.001	--	<0.001
Silver	0.01	0.017	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.00015	0.00024	--	--	--	--	--	--	--	--	--	--	--	--
Uranium	0.00118	--	--	--	--	--	--	--	--	--	**0.0013 J,K,B**	--	**0.0019 J,K,B**	--
Vanadium	0.00491	--	<0.005	--	<0.005	--	<0.005 X	--	**0.00261 J,K,B**	--	**0.0021 J,K,B**	--	**0.0022 J,K,B**	--
Zinc	0.0147	0.26	--	--	--	--	--	--	**0.011 J,K,B**	--	<0.002 K	--	**0.004 J,K,B**	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	--	--	--	--	--	--	**116**	--	**175**	--	**140**
Alkalinity, Carbonate	--	--	--	--	--	--	--	--	--	**34**	--	**19 J,B**	--	**18 J,B**
Alkalinity, Hydroxide (as CaCO3)	--	--	--	--	--	--	--	--	--	<2.0	--	<2.0	--	<2.0
Alkalinity, Total (as CaCO3)	--	--	--	--	--	--	--	--	--	**150**	--	**194**	--	**158**
Calcium	98.1	--	**60.9**	--	**60.4**	--	**63.5**	--	**61.8 J,K,B**	--	**72.5 J,K,B**	--	**70.6 J,K,B**	--
Chloride (as Cl)	--	--	--	--	--	--	--	--	**2.1 J,B**	--	**51.7**	--	**81.3**	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	**282**	--	**224**	--	**289**	--	--	--	**286**	--	**320**	--
Magnesium	20.2	--	**31.4**	--	**17.7**	--	**31.7**	--	**25.4 J,K,B**	--	**25.4 J,K,B**	--	**34.8 J,K,B**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	3	--	--	--	--	--	--	--	**2.8 J,K,B**	--	**2.5 J,K,B**	--	**3.7 J,K,B**	--
Sulfate (as SO4)	--	--	**173 D**	--	**58**	--	**165 D**	--	**8.6 J**	--	**111 J-**	--	**173**	--
Sodium	--	--	--	--	--	--	--	--	**44.5 J,K,B**	--	**41.6 J,K,B**	--	**68.6 J,K,B**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total dissolved solids (Residue, filterable)	--	--	--	**512**	--	**280**	--	**512**	--	--	--	--	--	--
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-6b

SUMMARY OF SURFACE WATER (DOWNSTREAM) RESULTS - HENRY SITE
P4 RI/FS

		Location Identification	MST045		MST045		MST045		MST045 Duplicate		MST045 Triplicate		MST045 Average	
		Location Type	Stream		Stream		Stream		Stream		Stream		Stream	
		Date Collected	5/14/2008		9/17/2008		5/5/2009		5/5/2009		5/5/2009		5/5/2009	
Analyte/Methods (Units)														
	Background	**Screening [a]**												
Metals (mg/l)	**mg/l**	**mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	0.272	0.087	--	**0.06 J-,B,K**	<0.05	--	--	--	--	--	--	--	--	--
Antimony	--	0.0056	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.00109	0.0062	--	--	--	--	--	--	--	--	--	--	--	--
Barium	0.0953	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	0.002	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.0001	0.00098	<0.0001 K	--	<0.000125	--	<0.000125	--	<0.000125	--	<0.000125	--	<0.000125	--
Chromium, Total	0.00284	0.011	<0.0001 K	--	**0.00142 F**	--	--	--	--	--	--	--	--	--
Cobalt	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	0.01	0.025	--	--	--	--	--	--	--	--	--	--	--	--
Iron	0.112	0.3	--	--	<0.025	--	**0.0304 F**	--	**0.03 F**	--	**0.0272 F**	--	**0.0292 J**	--
Lead	--	0.0069	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	0.055	0.05	--	--	**0.0121**	--	--	--	--	--	--	--	--	--
Mercury	--	0.00077	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	0.0027	0.12	**0.0025 J,K,B**	--	**0.00303 F**	--	--	--	--	--	--	--	--	--
Selenium	0.000772	0.0031	--	<0.001	--	**0.00115**	--	**0.00107 J**	--	**0.000965 F,J**	--	**).000883 F,J+,I**	--	**0.000973 J**
Silver	0.01	0.017	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.00015	0.00024	--	--	--	--	--	--	--	--	--	--	--	--
Uranium	0.00118	--	**0.0011 J,K,B**	--	--	--	--	--	--	--	--	--	--	--
Vanadium	0.00491	--	**0.0018 J,K,B**	--	<0.025	--	<0.005	--	<0.005	--	<0.005	--	<0.005	--
Zinc	0.0147	0.26	**0.01 J,K,B**	--	**0.0141 F**	--	--	--	--	--	--	--	--	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	**171**	--	--	--	--	--	--	--	--	--	--
Alkalinity, Carbonate	--	--	--	**7.0 J,B**	--	--	--	--	--	--	--	--	--	--
Alkalinity, Hydroxide (as CaCO3)	--	--	--	<2.0	--	--	--	--	--	--	--	--	--	--
Alkalinity, Total (as CaCO3)	--	--	--	**178**	**148**	--	--	--	--	--	--	--	--	--
Calcium	98.1	--	**66.8 J,K,B**	--	**68**	--	**49.5**	--	**47.7**	--	**51.1**	--	**49.4**	--
Chloride (as Cl)	--	--	**30.8 J-**	--	**82.6**	--	**12.7**	--	**12.7**	--	**12.7**	--	**12.7**	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	**245**	--	**311**	--	**172**	--	**166**	--	**177**	--	**172**	--
Magnesium	20.2	--	**19 J,K,B**	--	**34.3**	--	**11.6**	--	**11.3**	--	**12**	--	**11.6**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	3	--	**2.3 J,K,B**	--	**4.31**	--	--	--	--	--	--	--	--	--
Sulfate (as SO4)	--	--	**63.2 J-**	--	**169**	--	**23.8**	--	**23.6**	--	**23.8**	--	**23.7**	--
Sodium	--	--	**25.9 J,K,B**	--	**66.7**	--	--	--	--	--	--	--	--	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	<2.5	--	--	--	--	--	--	--	--
Total dissolved solids (Residue, filterable)	--	--	--	--	--	**672**	--	**250**	--	**250**	--	**240**	--	**247**
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-6b

SUMMARY OF SURFACE WATER (DOWNSTREAM) RESULTS - HENRY SITE
P4 RI/FS

Analyte/Methods (Units)		Location Identification / Location Type / Date Collected	MST045 Stream 9/21/2009		MST045 Duplicate Stream 9/21/2009		MST045 Triplicate Stream 9/21/2009		MST045 Average Stream 9/21/2009		MST045 Stream 5/14/2010		MST045 Duplicate Stream 5/14/2010	
Metals (mg/l)	**Background mg/l**	**Screening [a] mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	0.272	0.087	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	0.0056	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.00109	0.0062	--	--	--	--	--	--	--	--	--	--	--	--
Barium	0.0953	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	0.002	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.0001	0.00098	<0.000125	--	<0.000125	--	<0.000125	--	<0.000125	--	<0.0003	--	<0.0003	--
Chromium, Total	0.00284	0.011	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	0.01	0.025	--	--	--	--	--	--	--	--	--	--	--	--
Iron	0.112	0.3	<0.025	--	<0.025	--	<0.025	--	<0.025	--	<0.025	--	<0.025	--
Lead	--	0.0069	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	0.055	0.05	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	0.00077	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	0.0027	0.12	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	0.000772	0.0031	--	**0.00103**	--	**0.00172**	--	**0.00107**	--	**0.00127**	--	**0.000867 J**	--	**0.000824 J**
Silver	0.01	0.017	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.00015	0.00024	--	--	--	--	--	--	--	--	--	--	--	--
Uranium	0.00118	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	0.00491	--	**0.00682 J**	--	**0.00764 J**	--	**0.00616 J**	--	**0.00687 J**	--	<0.005	--	<0.005	--
Zinc	0.0147	0.26	--	--	--	--	--	--	--	--	--	--	--	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Carbonate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Hydroxide (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Total (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	98.1	--	**68.7**	--	**66.7**	--	**64.8**	--	**66.7**	--	**78.9**	--	**78.5**	--
Chloride (as Cl)	--	--	**64.1**	--	**64.1**	--	**64.1**	--	**64.1**	--	**36.8**	--	**38.2**	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	**289**	--	**276**	--	**276**	--	**280**	--	**289**	--	**291**	--
Magnesium	20.2	--	**28.4**	--	**26.5**	--	**27.8**	--	**27.6**	--	**22.3**	--	**23.1**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	3	--	--	--	--	--	--	--	--	--	--	--	--	--
Sulfate (as SO4)	--	--	**131**	--	**130**	--	**130**	--	**130**	--	**71.1**	--	**73.1**	--
Sodium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total dissolved solids (Residue, filterable)	--	--	--	**452**	--	**486**	--	**476**	--	**471**	--	**362**	--	**380**
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-6b

SUMMARY OF SURFACE WATER (DOWNSTREAM) RESULTS - HENRY SITE
P4 RI/FS
(Page 8 of 22)

Analyte/Methods (Units)	Background mg/l	Screening [a] mg/l	MST045 Triplicate Stream 5/14/2010 Dissolved	MST045 Triplicate Stream 5/14/2010 Total	MST045 Average Stream 5/14/2010 Dissolved	MST045 Average Stream 5/14/2010 Total	MST045 Stream 9/16/2010 Dissolved	MST045 Stream 9/16/2010 Total	MST045 Duplicate Stream 9/16/2010 Dissolved	MST045 Duplicate Stream 9/16/2010 Total	MST045 Triplicate Stream 9/16/2010 Dissolved	MST045 Triplicate Stream 9/16/2010 Total	MST045 Average Stream 9/16/2010 Dissolved	MST045 Average Stream 9/16/2010 Total
Metals (mg/l)														
Aluminum	0.272	0.087	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	0.0056	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.00109	0.0062	--	--	--	--	--	--	--	--	--	--	--	--
Barium	0.0953	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	0.002	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.0001	0.00098	<0.0003	--	<0.0003	--	<0.0006 UJ	--	<0.0006 UJ	--	<0.0006 UJ	--	<0.0006 UJ	--
Chromium, Total	0.00284	0.011	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	0.01	0.025	--	--	--	--	--	--	--	--	--	--	--	--
Iron	0.112	0.3	<0.025	--	<0.025	--	**0.0382 B**	--	<0.025	--	<0.025	--	**0.0382 J+,B**	--
Lead	--	0.0069	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	0.055	0.05	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	0.00077	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	0.0027	0.12	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	0.000772	0.0031	--	**0.000698 J**	--	**0.000796 J**	--	<0.001	--	<0.001	--	<0.005 UJ	--	<0.005 UJ
Silver	0.01	0.017	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.00015	0.00024	--	--	--	--	--	--	--	--	--	--	--	--
Uranium	0.00118	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	0.00491	--	<0.005	--	<0.005	--	<0.005	--	<0.005	--	<0.005	--	<0.005	--
Zinc	0.0147	0.26	--	--	--	--	--	--	--	--	--	--	--	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Carbonate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Hydroxide (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Total (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	98.1	--	**81.2**	--	**79.5**	--	**69.6**	--	**65**	--	**66.5**	--	**67**	--
Chloride (as Cl)	--	--	**38.4**	--	**37.8**	--	**75**	--	**76.7**	--	**76.4**	--	**76**	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	**298**	--	**293**	--	**306**	--	**286**	--	**292**	--	**294**	--
Magnesium	20.2	--	**23.1**	--	**22.8**	--	**32.1**	--	**30**	--	**30.6**	--	**30.9**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	3	--	--	--	--	--	--	--	--	--	--	--	--	--
Sulfate (as SO4)	--	--	**73.8**	--	**72.7**	--	**153**	--	**156**	--	**156**	--	**155**	--
Sodium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total dissolved solids (Residue, filterable)	--	--	--	**576**	--	**439**	--	**494**	--	**512**	--	**528**	--	**511**
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-6b

SUMMARY OF SURFACE WATER (DOWNSTREAM) RESULTS - HENRY SITE
P4 RI/FS

		Location Identification	MST045		MST045 Duplicate		MST045 Average		MST045		MST045		MST045 Duplicate	
		Location Type	Stream		Stream		Stream		Stream		Stream		Stream	
		Date Collected	5/9/2012		5/9/2012		5/9/2012		9/17/2012		4/24/2013		4/24/2013	
Analyte/Methods (Units)														
	Background mg/l	**Screening [a] mg/l**												
Metals (mg/l)			**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	0.272	0.087	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	0.0056	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.00109	0.0062	--	--	--	--	--	--	--	--	--	--	--	--
Barium	0.0953	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	0.002	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.0001	0.00098	<0.0006 D	--	<0.0006 D	--	<0.0006 D	--	<0.0003	--	<0.0003	--	<0.0003	--
Chromium, Total	0.00284	0.011	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	0.01	0.025	--	--	--	--	--	--	--	--	--	--	--	--
Iron	0.112	0.3	--	--	--	--	--	--	--	--	--	--	--	--
Lead	--	0.0069	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	0.055	0.05	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	0.00077	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	0.0027	0.12	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	0.000772	0.0031	--	**0.00121 F,J+**	--	**0.00196 F,J+**	--	**0.001585 F,J+**	--	**0.00166**	**0.00113**	**0.00113**	**0.00112**	**0.00125**
Silver	0.01	0.017	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.00015	0.00024	--	--	--	--	--	--	--	--	--	--	--	--
Uranium	0.00118	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	0.00491	--	<0.005	--	<0.005	--	<0.005	--	<0.005	--	<0.005	--	<0.005	--
Zinc	0.0147	0.26	--	--	--	--	--	--	--	--	--	--	--	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Carbonate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Hydroxide (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Total (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	98.1	--	**65.7**	--	**66.1**	--	**65.9**	--	**62.3**	--	**65.9**	--	**67.3**	--
Chloride (as Cl)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	**256**	--	**257**	--	**256.5**	--	**279**	--	**260**	--	**267**	--
Magnesium	20.2	--	**22.4**	--	**22.5**	--	**22.45**	--	**29.9**	--	**23.3 J**	--	**23.9 J**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	3	--	--	--	--	--	--	--	--	--	--	--	--	--
Sulfate (as SO4)	--	--	**110 J+**	--	**109 J+**	--	**109.5 J+**	--	**151 D**	--	**84.9 D**	--	**84.3 D**	--
Sodium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total dissolved solids (Residue, filterable)	--	--	--	**420**	--	**502**	--	**461**	--	**450**	--	**306**	--	**390**
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-6b

SUMMARY OF SURFACE WATER (DOWNSTREAM) RESULTS - HENRY SITE
P4 RI/FS

Analyte/Methods (Units)		Location Identification / Location Type / Date Collected	MST045 Average / Stream / 4/24/2013		MST045 / Stream / 9/23/2013		MST045 / Stream / 5/9/2014		MST045 Duplicate / Stream / 5/9/2014		MST045 Average / Stream / 5/9/2014		MST045 / Stream / 9/12/2014	
Metals (mg/l)	**Background mg/l**	**Screening [a] mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	0.272	0.087	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	0.0056	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.00109	0.0062	--	--	--	--	--	--	--	--	--	--	--	--
Barium	0.0953	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	0.002	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.0001	0.00098	<0.0003	--	<0.0003	--	<0.0003	--	<0.0003	--	<0.0003	--	<0.0003 X	--
Chromium, Total	0.00284	0.011	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	0.01	0.025	--	--	--	--	--	--	--	--	--	--	--	--
Iron	0.112	0.3	--	--	--	--	--	--	--	--	--	--	--	--
Lead	--	0.0069	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	0.055	0.05	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	0.00077	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	0.0027	0.12	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	0.000772	0.0031	**0.001125**	**0.00119**	**0.00114**	**0.000959 F**	**0.00107**	**0.00103**	**0.000664 F**	**0.000617 F**	**0.000867**	**0.000824**	**0.000876 F**	**0.000988 F**
Silver	0.01	0.017	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.00015	0.00024	--	--	--	--	--	--	--	--	--	--	--	--
Uranium	0.00118	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	0.00491	--	<0.005	--	<0.005	--	<0.005	--	<0.005	--	<0.005	--	<0.005 X	--
Zinc	0.0147	0.26	--	--	--	--	--	--	--	--	--	--	--	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Carbonate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Hydroxide (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Total (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	98.1	--	**66.6**	--	**68.4**	--	**59**	--	**60.4**	--	**59.7**	--	**67**	--
Chloride (as Cl)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	**263.5**	--	**308**	--	**218**	--	**224**	--	**221**	--	**295**	--
Magnesium	20.2	--	**23.6 J**	--	**33.4**	--	**17.1**	--	**17.7**	--	**17.4**	--	**31.1**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	3	--	--	--	--	--	--	--	--	--	--	--	--	--
Sulfate (as SO4)	--	--	**84.6 D**	--	**172 D**	--	**58.8**	--	**58.9**	--	**58.85**	--	**170 D**	--
Sodium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total dissolved solids (Residue, filterable)	--	--	--	**348**	--	**506**	--	**292**	--	**286**	--	**289**	--	**516**
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-6b

SUMMARY OF SURFACE WATER (DOWNSTREAM) RESULTS - HENRY SITE
P4 RI/FS
(Page 11 of 22)

Analyte/Methods (Units)		Location Identification	MST046		MST047		MST051		MST053		MST053		MST054	
		Location Type	Stream		Stream		Stream		Stream		Stream		Stream	
		Date Collected	5/21/2004		5/21/2004		5/5/2009		5/21/2004		10/3/2010		5/22/2004	
Metals (mg/l)	**Background mg/l**	**Screening [a] mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	0.272	0.087	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	0.0056	--	--	--	--	--	--	--	--	<0.003	--	--	--
Arsenic	0.00109	0.0062	--	--	--	--	--	--	--	--	**0.00075**	--	--	--
Barium	0.0953	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	0.002	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	0.02	--	--	--	--	--	--	--	--	--	**0.0146 B**	--	--	--
Cadmium	0.0001	0.00098	<0.0005 K	--	<0.0001 K	--	<0.000125	--	<0.0001 K	--	**0.000012 J**	--	<0.0001 K	--
Chromium, Total	0.00284	0.011	--	--	--	--	--	--	--	--	**0.00059**	--	--	--
Cobalt	0.01	--	--	--	--	--	--	--	--	--	**0.000964**	--	--	--
Copper	0.01	0.025	--	--	--	--	--	--	--	--	**0.00055**	--	--	--
Iron	0.112	0.3	--	--	--	--	**0.0281 F**	--	--	--	--	--	--	--
Lead	--	0.0069	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	0.055	0.05	--	--	--	--	--	--	--	--	**0.0087**	--	--	--
Mercury	--	0.00077	--	--	--	--	--	--	--	--	<0.00002	--	--	--
Molybdenum	0.01	--	--	--	--	--	--	--	--	--	<0.0006	--	--	--
Nickel	0.0027	0.12	<0.001 K	--	**0.0014 J,K,B**	--	--	--	**0.0009 J,K,B**	--	**0.00198**	--	**0.0007 J,K,B**	--
Selenium	0.000772	0.0031	--	<0.001	--	<0.001	--	**0.000705 F,B**	--	<0.001	--	**0.0007 J**	--	<0.001
Silver	0.01	0.017	--	--	--	--	--	--	--	--	<0.000004	--	--	--
Thallium	0.00015	0.00024	--	--	--	--	--	--	--	--	0.000002 UB	--	--	--
Uranium	0.00118	--	--	--	--	--	--	--	--	--	**0.000938**	--	--	--
Vanadium	0.00491	--	0.0007 UB,K	--	**0.00468 J,K,B**	--	<0.005	--	**0.00075 J,K,B**	--	**0.00115**	--	**0.00122 J,K,B**	--
Zinc	0.0147	0.26	<0.01 K	--	**0.003 J,K,B**	--	--	--	<0.002 K	--	**0.0008 J**	--	<0.002 K	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	**186**	--	**18**	--	--	--	**179**	--	--	--	**204**
Alkalinity, Carbonate	--	--	--	<2.0	--	**13**	--	--	--	<2.0	--	--	--	<2.0
Alkalinity, Hydroxide (as CaCO3)	--	--	--	<2.0	--	<2.0	--	--	--	<2.0	--	--	--	<2.0
Alkalinity, Total (as CaCO3)	--	--	--	**186**	--	**31**	--	--	--	**179**	--	--	--	**204**
Calcium	98.1	--	**57 J,K,B**	--	**88.4 J,K,B**	--	**21.6**	--	**56.6 J,K,B**	--	**56.5**	--	**64.5 J,K,B**	--
Chloride (as Cl)	--	--	**4.9 J**	--	**270 J**	--	**3.07**	--	**4.7**	--	--	--	**7.4**	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	--	--	--	--	**78**	--	--	--	**189**	--	--	--
Magnesium	20.2	--	**10.9 J,K,B**	--	**49.2 J,K,B**	--	**5.85**	--	**10.7 J,K,B**	--	**11.7**	--	**11.4 J,K,B**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	3	--	**1.7 J,K,B**	--	**7.8 J,K,B**	--	--	--	**1.9 J,K,B**	--	--	--	**0.7 J,K,B**	--
Sulfate (as SO4)	--	--	**5.4 J**	--	**180 J**	--	**27.9**	--	**5.8**	--	--	--	**10.1**	--
Sodium	--	--	**5.9 J,K,B**	--	**62 J,K,B**	--	--	--	**5.7 J,K,B**	--	--	--	**8.3 J,K,B**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total dissolved solids (Residue, filterable)	--	--	--	--	--	--	--	**146**	--	--	--	--	--	--
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-6b

SUMMARY OF SURFACE WATER (DOWNSTREAM) RESULTS - HENRY SITE
P4 RI/FS
(Page 12 of 22)

Analyte/Methods (Units)		Location Identification / Location Type / Date Collected	MST054 Stream 5/14/2007		MST054 Stream 9/9/2007		MST054 Stream 5/15/2008		MST054 Stream 9/19/2008		MST055 Stream 5/19/2004		MST056 Stream 5/5/2006	
Metals (mg/l)	**Background mg/l**	**Screening [a] mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	0.272	0.087	--	**0.35 J,K,B**	--	**3.48 J,K,B**	--	**0.21 J,K,B**	**0.844**	--	--	--	<0.03 K	--
Antimony	--	0.0056	--	--	--	--	--	--	--	--	--	--	<0.0004 K	--
Arsenic	0.00109	0.0062	--	--	--	--	--	--	--	--	--	--	<0.0005 K	--
Barium	0.0953	--	--	--	--	--	--	--	--	--	--	--	**0.052 J,K,B**	--
Beryllium	0.002	--	--	--	--	--	--	--	--	--	--	--	<0.002 K	--
Boron	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.0001	0.00098	<0.0001 UJ,K	--	<0.0001 K	--	<0.0001 K	--	<0.000125	--	<0.0001 K	--	<0.0001 K	--
Chromium, Total	0.00284	0.011	<0.0001 UJ,K	--	<0.0001 K	--	<0.0001 K	--	**0.0029 B**	--	--	--	<0.0001 K	--
Cobalt	0.01	--	--	--	--	--	--	--	--	--	--	--	<0.01 K	--
Copper	0.01	0.025	--	--	--	--	--	--	--	--	--	--	<0.01 K	--
Iron	0.112	0.3	--	--	--	--	--	--	**0.827**	--	--	--	<0.02 K	--
Lead	--	0.0069	--	--	--	--	--	--	--	--	--	--	**0.0004 J,K,B**	--
Manganese	0.055	0.05	--	--	--	--	--	--	**0.049**	--	--	--	**0.0117 J,K,B**	--
Mercury	--	0.00077	--	--	--	--	--	--	--	--	--	--	<0.0002	--
Molybdenum	0.01	--	--	--	--	--	--	--	--	--	--	--	<0.01 K	--
Nickel	0.0027	0.12	**0.0011 J,K,B**	--	**0.0015 J,K,B**	--	**0.0022 J,K,B**	--	**0.00339 F**	--	**0.0003 J,K,B**	--	**0.0015 J,K,B**	--
Selenium	0.000772	0.0031	--	<0.001	--	<0.001	--	<0.001	--	**0.00129**	--	**0.002 J,B**	--	**0.002 J,B**
Silver	0.01	0.017	--	--	--	--	--	--	--	--	--	--	<0.01 UJ,K	--
Thallium	0.00015	0.00024	--	--	--	--	--	--	--	--	--	--	<0.0001 K	--
Uranium	0.00118	--	**0.0007 J,K**	--	**0.0008 B,K**	--	**0.0007 J,K,B**	--	--	--	--	--	**0.0013 J,K,B**	--
Vanadium	0.00491	--	**0.0011 J,K**	--	**0.0025 J,K,B**	--	**0.0011 B,K**	--	**0.00525 F**	--	**0.00082 J,K,B**	--	<0.0002 K	--
Zinc	0.0147	0.26	<0.002 UJ,K	--	<0.002 K	--	**0.003 J,K,B**	--	**0.00597 F**	--	<0.002 K	--	**0.004 J,K,B**	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	**191 J-**	--	**179**	--	**182**	--	--	--	**185**	--	**189**
Alkalinity, Carbonate	--	--	--	**16 J-,B**	--	**12 J,B**	--	**8.0 J,B**	--	--	--	**7.0 J,B**	--	<2.0
Alkalinity, Hydroxide (as CaCO3)	--	--	--	--	--	<2.0	--	<2.0	--	--	--	<2.0	--	<2.0
Alkalinity, Total (as CaCO3)	--	--	--	**207 J-**	--	**191**	--	**189**	**190**	--	--	**192**	--	**189**
Calcium	98.1	--	**66.6 J-,K**	--	**64.2 J,K,B**	--	**65.9 J,K,B**	--	**65**	--	**58.9 J,K,B**	--	**54.7 J,K,B**	--
Chloride (as Cl)	--	--	**5.6 J-**	--	**9.1**	--	**6.7**	--	**9.16**	--	**1.8 J,B**	--	**2.9 J,B**	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	**219**	--	**205**	--	**214**	--	**207**	--	--	--	**183**	--
Magnesium	20.2	--	**12.7 J,K,B**	--	**10.8 J,K,B**	--	**12 J,K,B**	--	**10.8**	--	**11.4 J,K,B**	--	**11.3 J,K,B**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.3 J,B**
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	3	--	**0.4 J,K,B**	--	**0.9 J,K,B**	--	**1.0 J,K,B**	--	**0.921 F**	--	**0.8 J,K,B**	--	**1.4 J,K,B**	--
Sulfate (as SO4)	--	--	**9.8 J-**	--	**11.2**	--	**15.7 J-**	--	**11.6**	--	**9.3**	--	**19.6**	--
Sodium	--	--	**8.4 J,K,B**	--	**7.8 J,K,B**	--	**8.4 J,K,B**	--	**7.73**	--	**4.1 J,K,B**	--	**6.2 J,K,B**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	--	--	**18.5**	--	--	--	<5.0
Total dissolved solids (Residue, filterable)	--	--	--	--	--	--	--	--	--	**238**	--	--	**220**	--
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-6b

SUMMARY OF SURFACE WATER (DOWNSTREAM) RESULTS - HENRY SITE
P4 RI/FS
(Page 13 of 22)

Analyte/Methods (Units)		Location Identification Location Type Date Collected	MST057 Stream 5/18/2004		MST057 Stream 5/8/2006		MST057 Stream 5/10/2007		MST057 Stream 9/9/2007		MST057 Stream 5/15/2008		MST057 Stream 9/18/2008	
Metals (mg/l)	**Background mg/l**	**Screening [a] mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	0.272	0.087	--	--	**0.04 J,K,B**	--	--	**0.37 J,K,B**	--	**0.84 J,K,B**	--	**0.14 J,K,B**	<0.05	--
Antimony	--	0.0056	--	--	<0.0004 K	--	--	--	--	--	--	--	--	--
Arsenic	0.00109	0.0062	--	--	**0.0006 J,K,B**	--	--	--	--	--	--	--	--	--
Barium	0.0953	--	--	--	**0.042 J,K,B**	--	--	--	--	--	--	--	--	--
Beryllium	0.002	--	--	--	<0.002 K	--	--	--	--	--	--	--	--	--
Boron	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.0001	0.00098	<0.0002 K	--	<0.0001 K	--	<0.0001 UJ,K	--	<0.0001 K	--	<0.0001 K	--	<0.000125	--
Chromium, Total	0.00284	0.011	--	--	**0.0003 J,K,B**	--	<0.0001 UJ,K	--	<0.0001 K	--	<0.0001 K	--	**0.00208**	--
Cobalt	0.01	--	--	--	<0.01 K	--	--	--	--	--	--	--	--	--
Copper	0.01	0.025	--	--	<0.01 K	--	--	--	--	--	--	--	--	--
Iron	0.112	0.3	--	--	**0.02 J,K,B**	--	--	--	--	--	--	--	<0.025	--
Lead	--	0.0069	--	--	<0.0001 K	--	--	--	--	--	--	--	--	--
Manganese	0.055	0.05	--	--	**0.0119 J,K,B**	--	--	--	--	--	--	--	**0.0223**	--
Mercury	--	0.00077	--	--	<0.0002	--	--	--	--	--	--	--	--	--
Molybdenum	0.01	--	--	--	<0.01 K	--	--	--	--	--	--	--	--	--
Nickel	0.0027	0.12	0.0014 UB,K	--	**0.0009 J,K,B**	--	**0.0014 J,K,B**	--	**0.0014 J,K,B**	--	**0.0025 J,K,B**	--	**0.00413**	--
Selenium	0.000772	0.0031	--	**0.002 J,B**	--	**0.012**	--	**0.006**	--	**0.003 J,B**	--	**0.009**	--	**0.00445 J**
Silver	0.01	0.017	--	--	<0.01 K	--	--	--	--	--	--	--	--	--
Thallium	0.00015	0.00024	--	--	<0.0001 K	--	--	--	--	--	--	--	--	--
Uranium	0.00118	--	--	--	**0.004 J,K,B**	--	**0.0019 J,K**	--	**0.0026 J,K,B**	--	**0.0014 J,K,B**	--	--	--
Vanadium	0.00491	--	**0.0011 J,K,B**	--	**0.0015 J,K,B**	--	**0.0009 J-,B,K**	--	**0.0012 B,K**	--	0.0004 UB,K	--	<0.005	--
Zinc	0.0147	0.26	<0.004 K	--	<0.002 K	--	<0.002 UJ,K	--	**0.002 J,K,B**	--	<0.002 K	--	<0.005	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	**193**	--	**169**	--	**189**	--	**230**	--	**140**	--	--
Alkalinity, Carbonate	--	--	--	<2.0	--	<2.0	--	**5.0 J,B**	--	**10 J,B**	--	**4.0 J,B**	--	--
Alkalinity, Hydroxide (as CaCO3)	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	--
Alkalinity, Total (as CaCO3)	--	--	--	**193**	--	**169**	--	**194**	--	**240**	--	**144**	**224**	--
Calcium	98.1	--	**72.1 J,K,B**	--	**60 J,K,B**	--	**78.4 J,K,B**	--	**81.3 J,K,B**	--	**61.4 J,K,B**	--	**79.3**	--
Chloride (as Cl)	--	--	**2.9 J,B**	--	**2.0 J,B**	--	**2.6 J-,B**	--	**4.4**	--	**3.4**	--	**4.61**	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	--	--	**190**	--	**249**	--	**276**	--	**194**	--	**251**	--
Magnesium	20.2	--	**11.7 J,K,B**	--	**9.8 J,K,B**	--	**12.9 J,K,B**	--	**17.6 J,K,B**	--	**9.9 J,K,B**	--	**12.9**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	**0.3 J,B**	--	--	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	3	--	**0.5 J,K,B**	--	**1.2 J,K,B**	--	**0.5 J,K,B**	--	**0.8 J,K,B**	--	**1.4 J,K,B**	--	**0.742 F**	--
Sulfate (as SO4)	--	--	**38.8**	--	**39.1**	--	**51.6 J-**	--	**36.5**	--	**46.4 J-**	--	**43.3**	--
Sodium	--	--	**7.0 J,K,B**	--	**5.3 J,K,B**	--	**6.5 J,K,B**	--	**9.9 J,K,B**	--	**5.7 J,K,B**	--	**8.42**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	**8.0 J,B**	--	--	--	--	--	--	--	**29.5**
Total dissolved solids (Residue, filterable)	--	--	--	--	**230**	--	--	--	--	--	--	--	--	**286**
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-6b

SUMMARY OF SURFACE WATER (DOWNSTREAM) RESULTS - HENRY SITE
P4 RI/FS

		Location Identification	MST057		MST057		MST057		MST057		MST057		MST058	
		Location Type	Stream		Stream		Stream		Stream		Stream		Stream	
		Date Collected	5/5/2009		5/14/2010		5/9/2012		4/23/2013		5/7/2014		5/18/2004	
Analyte/Methods (Units)														
Metals (mg/l)	**Background mg/l**	**Screening [a] mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	0.272	0.087	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	0.0056	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.00109	0.0062	--	--	--	--	--	--	--	--	--	--	--	--
Barium	0.0953	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	0.002	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.0001	0.00098	<0.000125	--	<0.0003	--	<0.0006 D	--	<0.0003	--	<0.0003	--	<0.0001 K	--
Chromium, Total	0.00284	0.011	--	--	--	--	--	--	--	--	--	--	<0.0001 K	--
Cobalt	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	0.01	0.025	--	--	--	--	--	--	--	--	--	--	--	--
Iron	0.112	0.3	**0.0519 F**	--	<0.025	--	--	--	--	--	--	--	--	--
Lead	--	0.0069	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	0.055	0.05	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	0.00077	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	0.0027	0.12	--	--	--	--	--	--	--	--	--	--	0.0008 UB,K	--
Selenium	0.000772	0.0031	--	**0.0276**	--	**0.00617**	--	<0.001 D	**0.000585 F**	**0.00064 F**	<0.0005	**0.000585 F**	<0.001	<0.001
Silver	0.01	0.017	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.00015	0.00024	--	--	--	--	--	--	--	--	--	--	--	--
Uranium	0.00118	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	0.00491	--	<0.005	--	<0.005	--	<0.005	--	<0.005	--	<0.005	--	**0.00072 J,K,B**	--
Zinc	0.0147	0.26	--	--	--	--	--	--	--	--	--	--	**0.008 J,K,B**	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	--	--	--	--	--	--	--	--	--	--	**222**
Alkalinity, Carbonate	--	--	--	--	--	--	--	--	--	--	--	--	--	<2.0
Alkalinity, Hydroxide (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--	--	--	<2.0
Alkalinity, Total (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--	--	--	**222**
Calcium	98.1	--	**51**	--	**71.6**	--	**62.3**	--	**50.5**	--	**58.4**	--	**75.9 J,K,B**	--
Chloride (as Cl)	--	--	**2.89**	--	**3.2**	--	--	--	--	--	--	--	**3.3**	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	**163**	--	**231**	--	**205**	--	**168**	--	**191**	--	--	--
Magnesium	20.2	--	**8.73**	--	**13.1**	--	**12**	--	**10.3 J**	--	**10.9**	--	**13.4 J,K,B**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	3	--	--	--	--	--	--	--	--	--	--	--	**1.2 J,K,B**	--
Sulfate (as SO4)	--	--	**40.1**	--	**53.2**	--	**16 J+**	--	**19.7**	--	**14.4**	--	**18.5**	--
Sodium	--	--	--	--	--	--	--	--	--	--	--	--	**6.8 J,K,B**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total dissolved solids (Residue, filterable)	--	--	--	**220**	--	**330**	--	**238**	--	**200**	--	**240**	--	--
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-6b

SUMMARY OF SURFACE WATER (DOWNSTREAM) RESULTS - HENRY SITE
P4 RI/FS
(Page 15 of 22)

Analyte/Methods (Units)	Location Identification / Location Type / Date Collected		MST058 Stream 9/13/2004		MST058 Stream 5/8/2006		MST062 Stream 5/18/2004		MST064 Stream 5/18/2004		MST064 Stream 9/13/2004		MST064 Duplicate Stream 9/13/2004	
Metals (mg/l)	**Background mg/l**	**Screening [a] mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	0.272	0.087	--	--	<0.03 K	--	--	--	--	--	--	--	--	--
Antimony	--	0.0056	--	--	<0.0004 K	--	--	--	--	--	--	--	--	--
Arsenic	0.00109	0.0062	--	--	<0.0005 K	--	--	--	--	--	--	--	--	--
Barium	0.0953	--	--	--	**0.034 J,K,B**	--	--	--	--	--	--	--	--	--
Beryllium	0.002	--	--	--	<0.002 K	--	--	--	--	--	--	--	--	--
Boron	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.0001	0.00098	<0.0001 K	--	<0.0001 K	<0.0001 K	<0.0001 K	--	<0.0001 K	--	<0.0001 K	--	<0.0001 K	--
Chromium, Total	0.00284	0.011	<0.0001 K	--	**0.0003 J,K,B**	**0.0004 J,K,B**	--	--	<0.0001 K	--	<0.0001 K	--	<0.0001 K	--
Cobalt	0.01	--	--	--	<0.01 K	--	--	--	--	--	--	--	--	--
Copper	0.01	0.025	--	--	<0.01 K	--	--	--	--	--	--	--	--	--
Iron	0.112	0.3	--	--	**0.02 J,K,B**	--	--	--	--	--	--	--	--	--
Lead	--	0.0069	--	--	0.0001 UB,K	--	--	--	--	--	--	--	--	--
Manganese	0.055	0.05	--	--	**0.0092 J,K,B**	--	--	--	--	--	--	--	--	--
Mercury	--	0.00077	--	--	<0.0002	--	--	--	--	--	--	--	--	--
Molybdenum	0.01	--	--	--	<0.01 K	--	--	--	--	--	--	--	--	--
Nickel	0.0027	0.12	**0.0032 J,K,B**	--	**0.001 J,K,B**	**0.001 J,K,B**	0.0004 UB,K	--	0.0004 UB,K	--	**0.0015 J,K,B**	--	**0.0016 J,K,B**	--
Selenium	0.000772	0.0031	<0.001	<0.001	**0.013**	**0.009**	--	<0.001	**0.003 J,B**	**0.002 J,B**	**0.001 J,B**	**0.002 J,B**	**0.002 J,B**	**0.002 J,B**
Silver	0.01	0.017	--	--	<0.01 K	--	--	--	--	--	--	--	--	--
Thallium	0.00015	0.00024	--	--	<0.0001 K	--	--	--	--	--	--	--	--	--
Uranium	0.00118	--	--	--	**0.0011 J,K,B**	--	--	--	--	--	--	--	--	--
Vanadium	0.00491	--	**0.00132 J,K,B**	--	**0.0011 J,K,B**	**0.0007 J,K,B**	**0.00116 J,K,B**	--	**0.00065 J,K,B**	--	**0.00064 J,K,B**	--	**0.00069 J,K,B**	--
Zinc	0.0147	0.26	**0.003 J,K,B**	--	**0.003 J,K,B**	**0.002 J,K,B**	<0.002 K	--	<0.002 K	--	<0.002 K	--	**0.006 J,K,B**	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	**311**	--	**184**	--	**186**	--	**221**	--	**251**	--	**251**
Alkalinity, Carbonate	--	--	--	<2.0	--	<2.0	--	**4.0 J,B**	--	<2.0	--	<2.0	--	<2.0
Alkalinity, Hydroxide (as CaCO3)	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0
Alkalinity, Total (as CaCO3)	--	--	--	**311**	--	**184**	--	**190**	--	**221**	--	**251**	--	**251**
Calcium	98.1	--	**97.6 J,K,B**	--	**50.5 J,K,B**	--	**66.1 J,K,B**	--	**77.5 J,K,B**	--	**75.6 J,K,B**	--	**75.2 J,K,B**	--
Chloride (as Cl)	--	--	<5.0	--	**1.7 J,B**	--	**7.7**	--	**4.1**	--	**4.4**	--	**4.4**	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	--	--	**155**	--	--	--	--	--	--	--	--	--
Magnesium	20.2	--	**18 J,K,B**	--	**7.1 J,K,B**	--	**10.9 J,K,B**	--	**16.9 J,K,B**	--	**16.8 J,K,B**	--	**16.8 J,K,B**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	**0.3 J,B**	--	--	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	<0.02	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	**0.09 J**	--	--	--	--	--	--	--	--	--
Potassium	3	--	**3.4 J,K,B**	--	**1.1 J,K,B**	--	**0.7 J,K,B**	--	**0.6 J,K,B**	--	**0.7 J,K,B**	--	**0.8 J,K,B**	--
Sulfate (as SO4)	--	--	**33.8**	--	**25.9**	--	**12.1**	--	**40.3**	--	**39.1**	--	**39.2**	--
Sodium	--	--	**9.2 J,K,B**	--	**4.5 J,K,B**	--	**8.0 J,K,B**	--	**9.4 J,K,B**	--	**9.5 J,K,B**	--	**9.5 J,K,B**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	**8.0 J,B**	--	--	--	--	--	--	--	--
Total dissolved solids (Residue, filterable)	--	--	--	--	**180**	--	--	--	--	--	--	--	--	--
Total organic carbon	--	--	--	--	--	**8.0**	--	--	--	--	--	--	--	--

TABLE B-6b

SUMMARY OF SURFACE WATER (DOWNSTREAM) RESULTS - HENRY SITE
P4 RI/FS
(Page 16 of 22)

Analyte/Methods (Units)		**Location Identification**	**MST064 Triplicate**		**MST064 Average**		**MST064**		**MST226**		**MST226**		**MST226**	
		Location Type	**Stream**		**Stream**		**Stream**		**Stream**		**Stream**		**Stream**	
		Date Collected	**9/13/2004**		**9/13/2004**		**5/8/2006**		**5/8/2006**		**5/10/2012**		**5/13/2013**	
Metals (mg/l)	**Background mg/l**	**Screening [a] mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	0.272	0.087	--	--	--	--	<0.03 K	--	**0.18 J,K,B**	--	--	--	--	--
Antimony	--	0.0056	--	--	--	--	<0.0004 K	--	<0.0004 K	--	--	--	--	--
Arsenic	0.00109	0.0062	--	--	--	--	**0.001 J,K,B**	--	<0.0005 K	--	--	--	--	--
Barium	0.0953	--	--	--	--	--	**0.081 J,K,B**	--	**0.068 J,K,B**	--	--	--	--	--
Beryllium	0.002	--	--	--	--	--	<0.002 K	--	<0.002 K	--	--	--	--	--
Boron	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.0001	0.00098	<0.0001 K	--	<0.0001 K	--	0.0001 UB,K	**0.0001 J,K,B**	<0.0001 K	<0.0001 K	<0.0003	--	<0.0003	--
Chromium, Total	0.00284	0.011	<0.0001 K	--	<0.0001 K	--	**0.0003 J,K,B**	**0.0003 J,K,B**	**0.0004 J,K,B**	**0.0007 J,K,B**	--	--	--	--
Cobalt	0.01	--	--	--	--	--	<0.01 K	--	<0.01 K	--	--	--	--	--
Copper	0.01	0.025	--	--	--	--	<0.01 K	--	<0.01 K	--	--	--	--	--
Iron	0.112	0.3	--	--	--	--	<0.02 K	--	**0.09 J,K,B**	--	--	--	--	--
Lead	--	0.0069	--	--	--	--	<0.0001 K	--	<0.0001 K	--	--	--	--	--
Manganese	0.055	0.05	--	--	--	--	**0.0096 J,K,B**	--	**0.0018 J,K,B**	--	--	--	--	--
Mercury	--	0.00077	--	--	--	--	<0.0002	--	<0.0002	--	--	--	--	--
Molybdenum	0.01	--	--	--	--	--	<0.01 K	--	<0.01 K	--	--	--	--	--
Nickel	0.0027	0.12	**0.0016 J,K,B**	--	**0.00157 J,K,B**	--	**0.0012 J,K,B**	**0.0013 J,K,B**	<0.0006 K	<0.0006 K	--	--	--	--
Selenium	0.000772	0.0031	**0.001 J,B**	**0.002 J,B**	**0.00133 J**	**0.002 J**	**0.02**	**0.021**	<0.001	<0.001	--	**0.00833**	**0.00267**	**0.00272**
Silver	0.01	0.017	--	--	--	--	<0.01 K	--	<0.01 K	--	--	--	--	--
Thallium	0.00015	0.00024	--	--	--	--	<0.0001 K	--	<0.0001 K	--	--	--	--	--
Uranium	0.00118	--	--	--	--	--	**0.0206 J,K,B**	--	0.0003 UB,K	--	--	--	--	--
Vanadium	0.00491	--	**0.00063 J,K,B**	--	**0.000653 J,K,B**	--	**0.0034 J,K,B**	**0.0023 J,K,B**	**0.0005 J,K,B**	**0.0003 J,K,B**	<0.005	--	<0.005	--
Zinc	0.0147	0.26	<0.002 K	--	**0.006 J,K**	--	**0.002 J,K,B**	**0.004 J,K,B**	**0.002 J,K,B**	<0.002 K	--	--	--	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	**248**	--	**250**	--	**292**	--	**138**	--	--	--	--
Alkalinity, Carbonate	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	--	--	--
Alkalinity, Hydroxide (as CaCO3)	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	--	--	--
Alkalinity, Total (as CaCO3)	--	--	--	**248**	--	**250**	--	**292**	--	**138**	--	--	--	--
Calcium	98.1	--	**75.7 J,K,B**	--	**75.5 J,K,B**	--	**121 J,K,B**	--	**37.4 J,K,B**	--	**50.3**	--	**37.2**	--
Chloride (as Cl)	--	--	**3.5**	--	**4.1**	--	**3.3**	--	**2.5 J,B**	--	--	--	--	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	--	--	--	--	**395**	--	**120**	--	**167**	--	**122**	--
Magnesium	20.2	--	**16.9 J,K,B**	--	**16.8 J,K,B**	--	**22.6 J,K,B**	--	**6.5 J,K,B**	--	**10.2**	--	**7.04**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	**0.3 J,B**	--	**0.1 J,B**	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	<0.02	--	**0.02 J,B**	--	--	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	--	--	**0.14 J**	--	**0.1**	--	--	--	--	--
Potassium	3	--	**0.7 J,K,B**	--	**0.733 J,K**	--	**1.7 J,K,B**	--	**1.3 J,K,B**	--	--	--	--	--
Sulfate (as SO4)	--	--	**38.9**	--	**39.1**	--	**105**	--	**15**	--	**29.7**	--	**20.1**	--
Sodium	--	--	**9.6 J,K,B**	--	**9.53 J,K,B**	--	**8.1 J,K,B**	--	**3.0 J,K,B**	--	--	--	--	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	<5.0	--	<5.0	--	--	--	--
Total dissolved solids (Residue, filterable)	--	--	--	--	--	--	**460**	--	**140**	--	--	**166**	--	**148**
Total organic carbon	--	--	--	--	--	--	--	**7.0**	--	**3.0 J,B**	--	--	--	--

TABLE B-6b

SUMMARY OF SURFACE WATER (DOWNSTREAM) RESULTS - HENRY SITE
P4 RI/FS
(Page 17 of 22)

		Location Identification	MST226		MST234		MST234 Duplicate		MST234 Triplicate		MST234 Average		MST234	
		Location Type	Stream		Stream		Stream		Stream		Stream		Stream	
		Date Collected	5/7/2014		5/20/2004		5/20/2004		5/20/2004		5/20/2004		5/7/2006	
Analyte/Methods (Units)														
Metals (mg/l)	**Background mg/l**	**Screening [a] mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	0.272	0.087	--	--	--	--	--	--	--	--	--	--	<0.03 K	--
Antimony	--	0.0056	--	--	--	--	--	--	--	--	--	--	<0.0004 K	--
Arsenic	0.00109	0.0062	--	--	--	--	--	--	--	--	--	--	**0.0005 J,K,B**	--
Barium	0.0953	--	--	--	--	--	--	--	--	--	--	--	**0.055 J,K,B**	--
Beryllium	0.002	--	--	--	--	--	--	--	--	--	--	--	<0.002 K	--
Boron	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.0001	0.00098	<0.0003	--	<0.0001 K	--	<0.0001 K	--	<0.0002 K	--	<0.0002 K	--	<0.0001 K	--
Chromium, Total	0.00284	0.011	--	--	--	--	--	--	--	--	--	--	**0.0004 J,K,B**	--
Cobalt	0.01	--	--	--	--	--	--	--	--	--	--	--	<0.01 K	--
Copper	0.01	0.025	--	--	--	--	--	--	--	--	--	--	<0.01 K	--
Iron	0.112	0.3	--	--	--	--	--	--	--	--	--	--	<0.02 K	--
Lead	--	0.0069	--	--	--	--	--	--	--	--	--	--	<0.0001 K	--
Manganese	0.055	0.05	--	--	--	--	--	--	--	--	--	--	**0.009 J,K,B**	--
Mercury	--	0.00077	--	--	--	--	--	--	--	--	--	--	<0.0002	--
Molybdenum	0.01	--	--	--	--	--	--	--	--	--	--	--	<0.01 K	--
Nickel	0.0027	0.12	--	--	**0.0021 J,K,B**	--	**0.0019 J,K,B**	--	**0.0016 J,K,B**	--	**0.00187 J,K,B**	--	**0.0012 J,K,B**	--
Selenium	0.000772	0.0031	**0.00204**	**0.00218**	--	<0.001	--	<0.001	--	<0.001	--	<0.001	--	<0.001
Silver	0.01	0.017	--	--	--	--	--	--	--	--	--	--	<0.01 K	--
Thallium	0.00015	0.00024	--	--	--	--	--	--	--	--	--	--	<0.0001 K	--
Uranium	0.00118	--	--	--	--	--	--	--	--	--	--	--	**0.0014 J,K,B**	--
Vanadium	0.00491	--	<0.005	--	**0.00094 J,K,B**	--	**0.0009 J,K,B**	--	**0.0008 J,K,B**	--	**0.00088 J,K,B**	--	**0.0007 J,K,B**	--
Zinc	0.0147	0.26	--	--	**0.005 J,K,B**	--	**0.005 J,K,B**	--	<0.004 K	--	**0.005 J,K**	--	**0.005 J,K,B**	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	--	--	**482**	--	**486**	--	**416**	--	**461.3**	--	**284**
Alkalinity, Carbonate	--	--	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0
Alkalinity, Hydroxide (as CaCO3)	--	--	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0
Alkalinity, Total (as CaCO3)	--	--	--	--	--	**482**	--	**486**	--	**416**	--	**461.3**	--	**284**
Calcium	98.1	--	**33**	--	**141 J,K,B**	--	**142 J,K,B**	--	**144 J,K,B**	--	**142.3 J,K,B**	--	**99.9 J,K,B**	--
Chloride (as Cl)	--	--	--	--	**16.4**	--	**16.3**	--	**16.3**	--	**16.33**	--	**19.8**	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	**106**	--	--	--	--	--	--	--	--	--	**356**	--
Magnesium	20.2	--	**5.72**	--	**37.1 J,K,B**	--	**37.4 J,K,B**	--	**37.4 J,K,B**	--	**37.3 J,K,B**	--	**25.8 J,K,B**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.3 J,B**
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	3	--	--	--	**2.3 J,K,B**	--	**2.3 J,K,B**	--	**2.3 J,K,B**	--	**2.3 J,K,B**	--	**2.1 J,K,B**	--
Sulfate (as SO4)	--	--	**14.1**	--	**41.6**	--	**41.8**	--	**40.1**	--	**41.17**	--	**43.3**	--
Sodium	--	--	--	--	**13.8 J,K,B**	--	**13.9 J,K,B**	--	**14.5 J,K,B**	--	**14.07 J,K,B**	--	**18.1 J,K,B**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	--	--	--	--	--	--	**8.0 J,B**
Total dissolved solids (Residue, filterable)	--	--	--	**146**	--	--	--	--	--	--	--	--	**400**	--
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-6b

SUMMARY OF SURFACE WATER (DOWNSTREAM) RESULTS - HENRY SITE
P4 RI/FS
(Page 18 of 22)

Location Identification			**MST234 Duplicate**		**MST234 Triplicate**		**MST234 Average**		**MST234**		**MST234**		**MST234 Duplicate**	
Location Type			**Stream**		**Stream**		**Stream**		**Stream**		**Stream**		**Stream**	
Date Collected			**5/7/2006**		**5/7/2006**		**5/7/2006**		**5/10/2007**		**9/9/2007**		**9/9/2007**	
Analyte/Methods (Units)														
Metals (mg/l)	**Background mg/l**	**Screening [a] mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	0.272	0.087	<0.03 K	--	**0.14 J,K,B**	--	**0.14 J,K,B**	--	--	**0.05 J,K,B**	--	<0.03 K	--	<0.03 K
Antimony	--	0.0056	<0.0004 K	--	<0.0004 K	--	<0.0004 K	--	--	--	--	--	--	--
Arsenic	0.00109	0.0062	**0.0005 J,K,B**	--	**0.0006 J,K,B**	--	**0.00053 J,K,B**	--	--	--	--	--	--	--
Barium	0.0953	--	**0.054 J,K,B**	--	**0.055 J,K,B**	--	**0.0547 J,K,B**	--	--	--	--	--	--	--
Beryllium	0.002	--	<0.002 K	--	<0.002 K	--	<0.002 K	--	--	--	--	--	--	--
Boron	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.0001	0.00098	<0.0001 K	--	<0.0001 K	--	<0.0001 K	--	<0.0001 UJ,K	--	<0.0001 K	--	<0.0001 K	--
Chromium, Total	0.00284	0.011	**0.0003 J,K,B**	--	**0.0003 J,K,B**	--	**0.00033 J,K,B**	--	<0.0001 K	--	<0.0001 K	--	<0.0001 K	--
Cobalt	0.01	--	<0.01 K	--	<0.01 K	--	<0.01 K	--	--	--	--	--	--	--
Copper	0.01	0.025	<0.01 K	--	<0.01 K	--	<0.01 K	--	--	--	--	--	--	--
Iron	0.112	0.3	<0.02 K	--	<0.02 K	--	<0.02 K	--	--	--	--	--	--	--
Lead	--	0.0069	0.0001 UB,K	--	<0.0001 K	--	0.0001 UB,K	--	--	--	--	--	--	--
Manganese	0.055	0.05	**0.009 J,K,B**	--	**0.0086 J,K,B**	--	**0.00887 J,K,B**	--	--	--	--	--	--	--
Mercury	--	0.00077	<0.0002	--	<0.0002	--	<0.0002	--	--	--	--	--	--	--
Molybdenum	0.01	--	<0.01 K	--	<0.01 K	--	<0.01 K	--	--	--	--	--	--	--
Nickel	0.0027	0.12	**0.0011 J,K,B**	--	**0.0013 J,K,B**	--	**0.0012 J,K,B**	--	**0.0026 J,K,B**	--	**0.0035 J,K,B**	--	**0.0034 J,K,B**	--
Selenium	0.000772	0.0031	--	<0.001	--	<0.001	--	<0.001	--	<0.001	--	<0.001	--	<0.001
Silver	0.01	0.017	<0.01 K	--	<0.01 K	--	<0.01 K	--	--	--	--	--	--	--
Thallium	0.00015	0.00024	<0.0001 K	--	<0.0001 K	--	<0.0001 K	--	--	--	--	--	--	--
Uranium	0.00118	--	**0.0014 J,K,B**	--	**0.0014 J,K,B**	--	**0.0014 J,K,B**	--	**0.0016 J,K**	--	**0.0021 J+,K**	--	**0.002 J+,K**	--
Vanadium	0.00491	--	**0.0007 J,K,B**	--	**0.0007 J,K,B**	--	**0.0007 J,K,B**	--	**0.0008 J-,B,K**	--	**0.0012 B,K**	--	**0.0011 B,K**	--
Zinc	0.0147	0.26	**0.004 J,K,B**	--	**0.004 J,K,B**	--	**0.0043 J,K,B**	--	**0.005 J,K,B**	--	**0.007 J,K,B**	--	**0.008 J,K,B**	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	**310**	--	**309**	--	**301**	--	**411**	--	**451**	--	**452**
Alkalinity, Carbonate	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0
Alkalinity, Hydroxide (as CaCO3)	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0
Alkalinity, Total (as CaCO3)	--	--	--	**310**	--	**309**	--	**301**	--	**411**	--	**451**	--	**452**
Calcium	98.1	--	**100 J,K,B**	--	**102 J,K,B**	--	**100.63 J,K,B**	--	**131 J,K,B**	--	**134 J,K,B**	--	**133 J,K,B**	--
Chloride (as Cl)	--	--	**19.7**	--	**19.8**	--	**19.77**	--	**23.9 J-**	--	**21.8**	--	**21.7**	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	**357**	--	**363**	--	**358.7**	--	**475**	--	**486**	--	**483**	--
Magnesium	20.2	--	**26 J,K,B**	--	**26.2 J,K,B**	--	**26 J,K,B**	--	**35.8 J,K,B**	--	**36.7 J,K,B**	--	**36.5 J,K,B**	--
Nitrogen, Kjeldahl, Total	--	--	--	**0.3 J,B**	--	**0.3 J,B**	--	**0.3 J,B**	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	3	--	**2.4 J,K,B**	--	**2.4 J,K,B**	--	**2.3 J,K,B**	--	**2.2 J,K,B**	--	**2.3 J,K,B**	--	**2.6 J,K,B**	--
Sulfate (as SO4)	--	--	**43.3**	--	**43.4**	--	**43.33**	--	**55.7 J-**	--	**54.1**	--	**53.9**	--
Sodium	--	--	**18.2 J,K,B**	--	**18.3 J,K,B**	--	**18.2 J,K,B**	--	**20.2 J,K,B**	--	**19.2 J,K,B**	--	**18.9 J,K,B**	--
Suspended solids (Residue, non-filterable)	--	--	--	**6.0 J,B**	--	<5.0	--	**7.0 J**	--	--	--	--	--	--
Total dissolved solids (Residue, filterable)	--	--	**420**	--	**400**	--	**406.7**	--	--	--	--	--	--	--
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-6b

SUMMARY OF SURFACE WATER (DOWNSTREAM) RESULTS - HENRY SITE
P4 RI/FS

Location Identification			MST234 Triplicate		MST234 Average		MST234		MST234		MST271		MST275	
Location Type			Stream		Stream		Stream		Stream		Stream		Stream	
Date Collected			9/9/2007		9/9/2007		5/10/2008		9/19/2008		5/9/2006		5/18/2004	
Analyte/Methods (Units)														
Metals (mg/l)	**Background mg/l**	**Screening [a] mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	0.272	0.087	--	**0.03 J,K,B**	--	**0.03 J,K,B**	--	0.11 UB,K	<0.05	--	<0.03 K	--	--	--
Antimony	--	0.0056	--	--	--	--	--	--	--	--	<0.0004 K	--	--	--
Arsenic	0.00109	0.0062	--	--	--	--	--	--	--	--	0.0023 UB,K	--	--	--
Barium	0.0953	--	--	--	--	--	--	--	--	--	**0.042 J,K,B**	--	--	--
Beryllium	0.002	--	--	--	--	--	--	--	--	--	<0.002 K	--	--	--
Boron	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.0001	0.00098	<0.0001 K	--	<0.0001 K	--	<0.0001 K	--	<0.000125	--	<0.0001 K	--	<0.0002 K	--
Chromium, Total	0.00284	0.011	<0.0001 K	--	<0.0001 K	--	<0.0001 K	--	0.00105 F,UB	--	**0.0003 J,K,B**	--	**0.0005 J,K,B**	--
Cobalt	0.01	--	--	--	--	--	--	--	--	--	<0.01 K	--	--	--
Copper	0.01	0.025	--	--	--	--	--	--	--	--	<0.01 K	--	--	--
Iron	0.112	0.3	--	--	--	--	--	--	<0.025	--	**0.03 J,K,B**	--	--	--
Lead	--	0.0069	--	--	--	--	--	--	--	--	<0.0001 K	--	--	--
Manganese	0.055	0.05	--	--	--	--	--	--	**0.00265 B**	--	**0.0196 J,K,B**	--	--	--
Mercury	--	0.00077	--	--	--	--	--	--	--	--	<0.0002	--	--	--
Molybdenum	0.01	--	--	--	--	--	--	--	--	--	<0.01 K	--	--	--
Nickel	0.0027	0.12	**0.0037 J,K,B**	--	**0.00353 J,K,B**	--	**0.0036 J,K,B**	--	**0.00634**	--	**0.0022 J,K,B**	--	**0.0053 J,K,B**	--
Selenium	0.000772	0.0031	--	<0.001	--	<0.001	--	<0.001	--	**0.00164 B**	--	<0.001	<0.001	<0.001
Silver	0.01	0.017	--	--	--	--	--	--	--	--	<0.01 K	--	--	--
Thallium	0.00015	0.00024	--	--	--	--	--	--	--	--	<0.0001 K	--	--	--
Uranium	0.00118	--	**0.0021 J+,K**	--	**0.00207 J+,K**	--	**0.0014 J,K,B**	--	--	--	**0.0013 J,K,B**	--	--	--
Vanadium	0.00491	--	**0.0012 B,K**	--	**0.00117 K**	--	**0.0672 J,K,B**	--	<0.005	--	**0.002 J,K,B**	--	**0.011 J,K,B**	--
Zinc	0.0147	0.26	**0.006 J,K,B**	--	**0.007 J,K,B**	--	**0.005 J,K,B**	--	**0.00769 F**	--	**0.005 J,K,B**	--	<0.004 K	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	**452**	--	**451.7**	--	**329**	--	--	--	**158**	--	**59**
Alkalinity, Carbonate	--	--	--	<2.0	--	<2.0	--	<2.0	--	--	--	**77**	--	<2.0
Alkalinity, Hydroxide (as CaCO3)	--	--	--	<2.0	--	<2.0	--	<2.0	--	--	--	<2.0	--	<2.0
Alkalinity, Total (as CaCO3)	--	--	--	**452**	--	**451.7**	--	**329**	**493**	--	--	**235**	--	**59**
Calcium	98.1	--	**133 J,K,B**	--	**133.3 J,K,B**	--	**111 J,K,B**	--	**133**	--	**52.8 J,K,B**	--	**15.9 J,K,B**	--
Chloride (as Cl)	--	--	**21.7**	--	**21.73**	--	**22**	--	**50.3**	--	**6.2**	--	**5.6**	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	**482**	--	**483.7**	--	**398**	--	**482**	--	**182**	--	--	--
Magnesium	20.2	--	**36.4 J,K,B**	--	**36.53 J,K,B**	--	**29.4 J,K,B**	--	**36.7**	--	**12.2 J,K,B**	--	**4.1 J,K,B**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	--	--	--	--	**0.8**	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	3	--	**2.4 J,K,B**	--	**2.43 J,K,B**	--	**2.5 J,K,B**	--	**2.4**	--	**3.4 J,K,B**	--	**19.8 J,K,B**	--
Sulfate (as SO4)	--	--	**53.9**	--	**53.97**	--	**51**	--	**114**	--	**17.8**	--	**8.6**	--
Sodium	--	--	**19 J,K,B**	--	**19.03 J,K,B**	--	**19.2 J,K,B**	--	**17.7**	--	**9.9 J,K,B**	--	**4.6 J,K,B**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	--	--	<2.5	--	<5.0	--	--
Total dissolved solids (Residue, filterable)	--	--	--	--	--	--	--	--	--	**604**	**230**	--	--	--
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-6b

SUMMARY OF SURFACE WATER (DOWNSTREAM) RESULTS - HENRY SITE
P4 RI/FS
(Page 20 of 22)

Analyte/Methods (Units)		Location Identification / Location Type / Date Collected	MST275 Stream 9/14/2004		MST275 Stream 5/9/2006		MST275A Stream 10/1/2010		MST275B Stream 10/1/2010		MST275 Stream 5/13/2013		MST275 Stream 5/7/2014	
Metals (mg/l)	**Background mg/l**	**Screening [a] mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	0.272	0.087	--	--	**0.37 J,K,B**	--	--	--	--	--	--	--	--	--
Antimony	--	0.0056	--	--	<0.0004 K	--	<0.003	--	<0.003	--	--	--	--	--
Arsenic	0.00109	0.0062	--	--	0.0007 UB,K	--	**0.0194**	--	**0.0224**	--	--	--	--	--
Barium	0.0953	--	--	--	**0.024 J,K,B**	--	--	--	--	--	--	--	--	--
Beryllium	0.002	--	--	--	<0.002 K	--	--	--	--	--	--	--	--	--
Boron	0.02	--	--	--	--	--	**0.121**	--	**0.116**	--	--	--	--	--
Cadmium	0.0001	0.00098	<0.0005 UJ,K	--	<0.0001 K	<0.0001 K	**0.000126**	--	**0.000166**	--	<0.0003	--	<0.0003	--
Chromium, Total	0.00284	0.011	<0.0005 UJ,K	--	**0.0005 B,K**	**0.0011 J,K,B**	**0.00272**	--	**0.00343**	--	--	--	--	--
Cobalt	0.01	--	--	--	<0.01 K	--	**0.0132**	--	**0.0141**	--	--	--	--	--
Copper	0.01	0.025	--	--	<0.01 K	--	**0.00274**	--	**0.00379**	--	--	--	--	--
Iron	0.112	0.3	--	--	**0.17 J,K,B**	--	--	--	--	--	--	--	--	--
Lead	--	0.0069	--	--	**0.0004 J,K,B**	--	--	--	--	--	--	--	--	--
Manganese	0.055	0.05	--	--	**0.0079 J,K,B**	--	**1.74**	--	**2.33**	--	--	--	--	--
Mercury	--	0.00077	--	--	<0.0002	--	<0.00002	--	<0.00002	--	--	--	--	--
Molybdenum	0.01	--	--	--	<0.01 K	--	**0.0192**	--	**0.0191**	--	--	--	--	--
Nickel	0.0027	0.12	**0.02 J,K**	--	**0.0012 J,K,B**	**0.0015 J,K,B**	**0.0244**	--	**0.0265**	--	--	--	--	--
Selenium	0.000772	0.0031	<0.001	**0.008**	<0.001	<0.001	--	**0.006**	--	**0.0047**	<0.0005	<0.0005	<0.0005	<0.0005
Silver	0.01	0.017	--	--	<0.01 UJ,K	--	0.00001 UB	--	0.00002 UB	--	--	--	--	--
Thallium	0.00015	0.00024	--	--	<0.0001 K	--	**0.000348**	--	**0.000059**	--	--	--	--	--
Uranium	0.00118	--	--	--	<0.0001 K	--	**0.00173**	--	**0.00208**	--	--	--	--	--
Vanadium	0.00491	--	**0.0034 J,K,B**	--	**0.0006 J,K,B**	**0.0014 J,K,B**	**0.00612**	--	**0.0096**	--	<0.005	--	<0.005	--
Zinc	0.0147	0.26	<0.01 K	--	**0.005 J,K,B**	**0.006 J,K,B**	**0.0068**	--	**0.0113**	--	--	--	--	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	**629**	--	**39**	--	--	--	--	--	--	--	--
Alkalinity, Carbonate	--	--	--	<2.0	--	<2.0	--	--	--	--	--	--	--	--
Alkalinity, Hydroxide (as CaCO3)	--	--	--	<2.0	--	<2.0	--	--	--	--	--	--	--	--
Alkalinity, Total (as CaCO3)	--	--	--	**629**	--	**39**	--	--	--	--	--	--	--	--
Calcium	98.1	--	**74.8 J,K,B**	--	**5.8 J,K,B**	--	**72.4**	--	**73.3**	--	**8.45**	--	**6.88**	--
Chloride (as Cl)	--	--	**37**	--	**1.2 J,B**	--	--	--	--	--	--	--	--	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	--	--	**19**	--	**276**	--	**278**	--	**29.7**	--	**24.1**	--
Magnesium	20.2	--	**22.1 J,K,B**	--	**1.1 J,K,B**	--	**23.2**	--	**23.1**	--	**2.09**	--	**1.68**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	**0.3 J,B**	--	--	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	<0.02	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	**0.6 J**	--	--	--	--	--	--	--	--	--
Potassium	3	--	**102 J,K,B**	--	**1.9 J,K,B**	--	--	--	--	--	--	--	--	--
Sulfate (as SO4)	--	--	**2.2 J,B**	--	**4.5**	--	--	--	--	--	**2.76**	--	**1.72**	--
Sodium	--	--	**17 J,K,B**	--	**2.3 J,K,B**	--	--	--	--	--	--	--	--	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	<5.0	--	--	--	--	--	--	--	--
Total dissolved solids (Residue, filterable)	--	--	--	--	**50**	--	--	--	--	--	--	**80**	--	**82**
Total organic carbon	--	--	--	--	--	**6.0**	--	--	--	--	--	--	--	--

TABLE B-6b

SUMMARY OF SURFACE WATER (DOWNSTREAM) RESULTS - HENRY SITE
P4 RI/FS

Analyte/Methods (Units)		Location Identification	MST276		MST276		MST276		MST276		MST276		MST276		MST276	
		Location Type	Stream		Stream		Stream		Stream		Stream		Stream		Stream	
		Date Collected	5/18/2004		9/13/2004		5/8/2006		5/10/2007		9/11/2007		5/15/2008		10/6/2008	
Metals (mg/l)	Background mg/l	Screening [a] mg/l	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Aluminum	0.272	0.087	--	--	--	--	<0.03 K	--	--	<0.03 K	<0.03 K	<0.03 K	<0.03 K	**0.07 J-,B,K**	<0.05	**0.0933 F**
Antimony	--	0.0056	--	--	--	--	<0.0004 K	--	--	--	<0.0004 UJ,K	<0.0004 K	<0.0004 K	<0.0004 K	--	--
Arsenic	0.00109	0.0062	--	--	--	--	<0.0005 K	--	--	--	<0.0005 K	<0.0005 K	<0.0005 K	**0.0011 B,K**	--	--
Barium	0.0953	--	--	--	--	--	**0.063 J,K,B**	--	--	--	**0.066 J,K,B**	**0.066 J,K,B**	**0.063 J,K,B**	**0.061 J,K,B**	--	--
Beryllium	0.002	--	--	--	--	--	<0.002 K	--	--	--	<0.002 K	<0.002 K	<0.002 K	<0.002 K	--	--
Boron	0.02	--	--	--	--	--	--	--	--	--	**0.02 J,K,B**	**0.02 J,K,B**	<0.01 K	**0.02 J,K,B**	--	--
Cadmium	0.0001	0.00098	<0.0001 K	--	<0.0001 K	--	<0.0001 K	<0.0001 K	<0.0001 UJ,K	--	<0.0001 K	<0.0001 K	<0.0001 K	<0.0001 K	<0.000125	<0.000125
Chromium, Total	0.00284	0.011	**0.0002 J,K,B**	--	<0.0001 K	--	**0.0004 J,K,B**	**0.0005 J,K,B**	<0.0001 UJ,K	--	<0.0001 K	<0.0005 K	<0.0001 K	0.0003 UB,K	**0.00275**	**0.00229**
Cobalt	0.01	--	--	--	--	--	<0.01 K	--	--	--	<0.01 K	<0.01 K	<0.01 K	<0.01 K	--	--
Copper	0.01	0.025	--	--	--	--	<0.01 K	--	--	--	<0.01 K	<0.01 K	<0.01 K	<0.01 K	--	--
Iron	0.112	0.3	--	--	--	--	<0.02 K	--	--	--	<0.02 K	**0.03 J,K,B**	<0.02 K	**0.03 J-,B,K**	<0.025	**0.0752 F**
Lead	--	0.0069	--	--	--	--	0.0001 UB,K	--	--	--	<0.0001 K	<0.0001 K	<0.0001 K	**0.0001 J,K,B**	--	--
Manganese	0.055	0.05	--	--	--	--	**0.0032 J,K,B**	--	--	--	**0.0012 J,K,B**	**0.0017 J,K,B**	**0.0012 J,K,B**	**0.0021 J-,B,K**	**0.00869**	**0.00463**
Mercury	--	0.00077	--	--	--	--	<0.0002	--	--	--	<0.0002	<0.0002	<0.0002	<0.0002	--	--
Molybdenum	0.01	--	--	--	--	--	<0.01 K	--	--	--	<0.01 K	<0.01 K	<0.01 K	<0.01 K	--	--
Nickel	0.0027	0.12	**0.0013 B,K**	--	**0.002 J,K,B**	--	<0.0006 K	<0.0006 K	**0.0008 J,K,B**	--	**0.0011 J,K,B**	**0.0009 J,K,B**	**0.0021 J,K,B**	**0.0009 J,K,B**	**0.00341 F**	**0.00332 F**
Selenium	0.000772	0.0031	**0.003 J,B**	**0.003 J,B**	**0.002 J,B**	**0.013**	**0.003 J,B**	**0.005 J,B**	--	**0.006**	**0.003 J,B**	**0.003 J,B**	**0.006**	**0.005 J-,B**	**0.00383**	**0.00354**
Silver	0.01	0.017	--	--	--	--	<0.01 K	--	--	--	<0.01 K	<0.01 K	<0.01 K	<0.01 K	--	--
Thallium	0.00015	0.00024	--	--	--	--	<0.0001 K	--	--	--	0.0001 UB,K	**0.0006 B,K**	<0.0001 K	<0.0001 K	--	--
Uranium	0.00118	--	--	--	--	--	**0.0034 J,K,B**	--	**0.0032 J,K**	--	**0.0022 J,K,B**	**0.0022 J,K,B**	**0.0021 J,K,B**	**0.0023 J,K,B**	--	--
Vanadium	0.00491	--	**0.00108 J,K,B**	--	**0.00086 J,K,B**	--	**0.0009 J,K,B**	**0.0002 J,K,B**	**0.0004 J-,B,K**	--	**0.0007 J,K,B**	**0.0006 J,K,B**	<0.0002 K	**0.0009 J,K,B**	<0.005	<0.005
Zinc	0.0147	0.26	<0.002 K	--	<0.002 K	--	**0.002 J,K,B**	<0.002 K	<0.002 UJ,K	--	<0.002 K	<0.002 K	<0.002 K	<0.002 K	**0.11**	**0.00784 F**
Chemistry Parameters (mg/l)																
Alkalinity, Bicarbonate	--	--	--	**187**	--	**227**	--	**274**	--	**237**	--	**245**	--	**207**	--	--
Alkalinity, Carbonate	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	--
Alkalinity, Hydroxide (as CaCO3)	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	--
Alkalinity, Total (as CaCO3)	--	--	--	**187**	--	**227**	--	**274**	--	**237**	--	**245**	--	**207**	**248**	--
Calcium	98.1	--	**75.8 J,K,B**	--	**80.3 J,K,B**	--	**82.5 J,K,B**	--	**87.8 J,K,B**	--	**84 J,K,B**	**76.5 J,K,B**	**77.8 J,K,B**	**73.1 J,K,B**	**74.6**	--
Chloride (as Cl)	--	--	**2.4 J,B**	--	**4.5**	--	**3.6**	--	**4.1 J-**	--	**4.3**	--	**4.3**	--	**4.78**	--
Fluoride	--	--	--	--	--	--	--	--	--	--	**0.1 J,B**	--	<0.1	--	--	--
Hardness (as CaCO3)	--	--	--	--	--	--	**271**	--	**294**	--	**286**	--	**260**	**246**	**259**	--
Magnesium	20.2	--	**11.3 J,K,B**	--	**13 J,K,B**	--	**15.8 J,K,B**	--	**18.2 J,K,B**	--	**18.5 J,K,B**	**17 J,K,B**	**16 J,K,B**	**15.5 J,K,B**	**17.8**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	**0.1 J,B**	--	--	--	<0.1 ,UJ	--	0.4 UB	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	**0.29**	--	--	--	**0.22**	--	**870**	--	--
Phosphorus, total orthophosphate (as PO_4)	--	--	--	--	--	--	**0.06 J**	--	--	--	**0.03 J-,B**	--	**0.05 J**	--	--	--
Potassium	3	--	**0.5 J,K,B**	--	**0.7 J,K,B**	--	**0.8 J,K,B**	--	**0.6 J,K,B**	--	0.8 UB,K	**0.9 J,K,B**	**0.8 J,K,B**	**0.6 J,K,B**	**1.01 B**	--
Sulfate (as SO4)	--	--	**40.3**	--	**46.8**	--	**51**	--	**55.9 J-**	--	**36.7**	--	**53.2**	--	**39.3**	--
Sodium	--	--	**7.0 J,K,B**	--	**7.9 J,K,B**	--	**8.1 J,K,B**	--	**8.8 J,K,B**	--	**9.5 J,K,B**	**9.1 J,K,B**	**8.6 J,K,B**	**8.1 J,K,B**	**9.09**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	<5.0	--	--	--	<5.0	--	<5.0	--	<2.5
Total dissolved solids (Residue, filterable)	--	--	--	--	--	--	**310**	--	--	--	**300 J-**	--	**320 J-**	--	--	**318**
Total organic carbon	--	--	--	--	--	--	--	**5.0 J,B**	--	--	--	--	--	--	--	--

TABLE B-6b

SUMMARY OF SURFACE WATER (DOWNSTREAM) RESULTS - HENRY SITE
P4 RI/FS

Footnotes:

a The State of Idaho surface water quality criteria and the USEPA NRWQC values for metals with hardness-dependent toxicity (i.e., cadmium, chromium, copper, lead, nickel, silver, and zinc) were adjusted for the Site-specific hardness concentrations measured in upstream, downstream, and pond surface water locations. A water hardness levels of 256 mg/L was used to adjust surface water quality criteria for downstream locations.

mg/l	milligrams per liter.
Bold	Bolded result indicates positively identified compound.
--	Not scheduled.
	Blue shaded result indicates both screening limit and background limit exceeded.
	Yellow shaded result indicates non-detected result greater than background and screening level.
B	Analyte detected in an associated blank.
D	Sample dilution required for analysis; reported values reflect the dilution.
F	Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J	Data are estimated due to associated quality control data. Bias unknown.
J+	Data are estimated due to associated quality control data. Potential high bias.
J-	Data are estimated due to associated quality control data. Potential low bias.
K	Serial dilutions not performed for samples analyzed by the method (EPA 200.7; 200.8).
UB	Analyte considered not detected based on associated blank data.
UJ	Potential low bias, possible false negative.

TABLE B-7

SUMMARY OF GROUNDWATER RESULTS - HENRY SITE
P4 RI/FS
(Page 1 of 20)

Analyte/Methods (Units)		Location Identification Location Type Date Collected	BH030 Bore Hole 5/22/2008	BH058 Bore Hole 6/2/2008	BH059 Bore Hole 6/2/2008	BH063 Bore Hole 6/2/2008	BH073 Bore Hole 6/4/2008	BH074 Bore Hole 6/4/2008	BH075 Bore Hole 6/20/2008	BH076 Bore Hole 6/4/2008	BH077 Bore Hole 6/4/2008
Metals (mg/l)	**Background mg/l**	**Screening mg/l**	**Dissolved**	**Dissolved**	**Dissolved**	**Dissolved**	**Dissolved**	**Dissolved**	**Dissolved**	**Dissolved**	**Dissolved**
Aluminum	--	0.2	--	--	--	--	--	--	--	--	--
Antimony	--	0.006	--	--	--	--	--	--	--	--	--
Arsenic	0.00103	0.01	--	--	--	--	--	--	--	--	--
Barium	--	2	--	--	--	--	--	--	--	--	--
Beryllium	--	0.004	--	--	--	--	--	--	--	--	--
Boron	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.000401	0.005	--	--	--	--	--	--	--	--	--
Chromium, Total	0.00604	0.1	--	--	--	--	--	--	--	--	--
Cobalt	0.000436	--	--	--	--	--	--	--	--	--	--
Copper	--	1.3	--	--	--	--	--	--	--	--	--
Iron	--	0.3	--	--	--	--	--	--	--	--	--
Lead	0.00146	0.015	--	--	--	--	--	--	--	--	--
Manganese	0.435	0.05	--	--	--	--	--	--	--	--	--
Mercury	--	0.002	--	--	--	--	--	--	--	--	--
Molybdenum	0.0239	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	--	--	--
Selenium	0.00278	0.05	<0.001	<0.001	**0.041**	**0.13 D**	**0.003 F**	**0.031**	<0.001	<0.001	<0.001
Silver	--	0.1	--	--	--	--	--	--	--	--	--
Thallium	0.0002	0.002	--	--	--	--	--	--	--	--	--
Uranium	--	0.03	--	--	--	--	--	--	--	--	--
Vanadium	0.0138	--	--	--	--	--	--	--	--	--	--
Zinc	0.471	5	--	--	--	--	--	--	--	--	--
Chemistry Parameters (mg/l)											
Alkalinity, Bicarbonate	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Carbonate	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Hydroxide (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Total (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--
Calcium	--	--	--	--	--	--	--	--	--	--	--
Chloride (as Cl)	--	250	--	--	--	--	--	--	--	--	--
Fluoride	--	4	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--
Magnesium	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO4)	--	--	--	--	--	--	--	--	--	--	--
Potassium	--	--	--	--	--	--	--	--	--	--	--
Sodium	--	--	--	--	--	--	--	--	--	--	--
Sulfate (as SO4)	--	250	--	--	--	--	--	--	--	--	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	--	--	--	--
Total dissolved solids (Residue, filterable)	--	500	--	--	--	--	--	--	--	--	--
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--

TABLE B-7

SUMMARY OF GROUNDWATER RESULTS - HENRY SITE
P4 RI/FS

Analyte/Methods (Units)	Location Identification / Location Type / Date Collected		BH079 Bore Hole 6/20/2008	BH151 Bore Hole 5/12/2009	BH153 Bore Hole 5/12/2009	BH157 Bore Hole 5/12/2009	BH158 Bore Hole 5/12/2009	BH167 Bore Hole 8/17/2010	BH169 Bore Hole 8/17/2010	BH171 Bore Hole 8/17/2010
Metals (mg/l)	**Background mg/l**	**Screening mg/l**	**Dissolved**	**Dissolved**	**Dissolved**	**Dissolved**	**Dissolved**	**Dissolved**	**Dissolved**	**Dissolved**
Aluminum	--	0.2	--	--	--	--	--	--	--	--
Antimony	--	0.006	--	--	--	--	--	--	--	--
Arsenic	0.00103	0.01	--	--	--	--	--	--	--	--
Barium	--	2	--	--	--	--	--	--	--	--
Beryllium	--	0.004	--	--	--	--	--	--	--	--
Boron	--	--	--	--	--	--	--	--	--	--
Cadmium	0.000401	0.005	--	--	--	--	--	--	--	--
Chromium, Total	0.00604	0.1	--	--	--	--	--	--	--	--
Cobalt	0.000436	--	--	--	--	--	--	--	--	--
Copper	--	1.3	--	--	--	--	--	--	--	--
Iron	--	0.3	--	--	--	--	--	--	--	--
Lead	0.00146	0.015	--	--	--	--	--	--	--	--
Manganese	0.435	0.05	--	--	--	--	--	--	--	--
Mercury	--	0.002	--	--	--	--	--	--	--	--
Molybdenum	0.0239	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	--	--
Selenium	0.00278	0.05	<0.001	<0.0005	**0.00551**	**0.018 J**	**0.0318 J**	**0.0183**	**0.00157**	<0.0005
Silver	--	0.1	--	--	--	--	--	--	--	--
Thallium	0.0002	0.002	--	--	--	--	--	--	--	--
Uranium	--	0.03	--	--	--	--	--	--	--	--
Vanadium	0.0138	--	--	--	--	--	--	--	--	--
Zinc	0.471	5	--	--	--	--	--	--	--	--
Chemistry Parameters (mg/l)										
Alkalinity, Bicarbonate	--	--	--	--	--	--	--	--	--	--
Alkalinity, Carbonate	--	--	--	--	--	--	--	--	--	--
Alkalinity, Hydroxide (as CaCO3)	--	--	--	--	--	--	--	--	--	--
Alkalinity, Total (as CaCO3)	--	--	--	--	--	--	--	--	--	--
Calcium	--	--	--	--	--	--	--	--	--	--
Chloride (as Cl)	--	250	--	--	--	--	--	--	--	--
Fluoride	--	4	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	--	--	--	--	--	--	--	--
Magnesium	--	--	--	--	--	--	--	--	--	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO4)	--	--	--	--	--	--	--	--	--	--
Potassium	--	--	--	--	--	--	--	--	--	--
Sodium	--	--	--	--	--	--	--	--	--	--
Sulfate (as SO4)	--	250	--	--	--	--	--	--	--	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	--	--	--
Total dissolved solids (Residue, filterable)	--	500	--	--	--	--	--	--	--	--
Total organic carbon	--	--	--	--	--	--	--	--	--	--

TABLE B-7

SUMMARY OF GROUNDWATER RESULTS - HENRY SITE
P4 RI/FS

Analyte/Methods (Units)	Location Identification / Location Type / Date Collected		MBW152 Borehole Well 5/16/2009	MBW152 Borehole Well 5/24/2010		MBW152 Borehole Well 5/15/2012		MBW152 Borehole Well 4/26/2013		MBW152 Borehole Well 5/11/2014		MMW004 Monitoring Well 5/22/2004	
Metals (mg/l)	**Background mg/l**	**Screening mg/l**	**Dissolved**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	--	0.2	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	0.006	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.00103	0.01	--	--	--	--	--	--	--	--	--	--	--
Barium	--	2	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	0.004	--	--	--	--	--	--	--	--	--	--	--
Boron	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.000401	0.005	--	<0.0003	<0.0003	--	<0.0006 D	--	<0.0003	--	<0.0003	<0.0002 K	--
Chromium, Total	0.00604	0.1	--	--	--	--	--	--	--	--	--	<0.0002 K	--
Cobalt	0.000436	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	1.3	--	--	--	--	--	--	--	--	--	--	--
Iron	--	0.3	--	--	--	--	--	--	--	--	--	--	--
Lead	0.00146	0.015	--	--	--	--	--	--	--	--	--	--	--
Manganese	0.435	0.05	--	--	--	--	**0.108 J+**	--	**0.303 D**	--	**0.11**	--	--
Mercury	--	0.002	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	0.0239	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	--	--	--	<0.0004 K	--
Selenium	0.00278	0.05	**0.00536 J**	**0.00199**	**0.00206**	--	**0.0023 D**	**0.00241**	**0.00214**	**0.00225**	**0.00188**	<0.001	--
Silver	--	0.1	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.0002	0.002	--	--	--	--	--	--	--	--	--	--	--
Uranium	--	0.03	--	--	--	--	--	--	--	--	--	--	--
Vanadium	0.0138	--	--	--	--	--	--	--	--	--	--	**0.0013 J,K,B**	--
Zinc	0.471	5	--	--	--	--	--	--	--	--	--	<0.004 K	--
Chemistry Parameters (mg/l)													
Alkalinity, Bicarbonate	--	--	--	--	--	--	--	--	--	--	--	--	**141**
Alkalinity, Carbonate	--	--	--	--	--	--	--	--	--	--	--	--	<2.0
Alkalinity, Hydroxide (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--	--	<2.0
Alkalinity, Total (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--	--	**141**
Calcium	--	--	--	--	--	--	--	--	--	--	--	**76.2 J,K,B**	--
Chloride (as Cl)	--	250	--	--	--	--	--	--	--	--	--	**66**	--
Fluoride	--	4	--	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--	--	--
Magnesium	--	--	--	--	--	--	--	--	--	--	--	**26.5 J,K,B**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO4)	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	--	--	--	--	--	--	--	--	--	--	--	**3.6 J,K,B**	--
Sodium	--	--	--	--	--	--	--	--	--	--	--	**45.8 J,K,B**	--
Sulfate (as SO4)	--	250	--	**128**	--	**111**	--	**124 D**	--	**113 D**	--	**134**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	--	--	--	--	--	--
Total dissolved solids (Residue, filterable)	--	500	--	--	**510**	--	**434**	--	**426**	--	**350**	--	--
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-7

SUMMARY OF GROUNDWATER RESULTS - HENRY SITE
P4 RI/FS

Analyte/Methods (Units)	Location Identification / Location Type / Date Collected		MMW004 Dup / Monitoring Well / 5/22/2004		MMW004 Triplicate / Monitoring Well / 5/22/2004		MMW004 Average / Monitoring Well / 5/22/2004		MMW004 / Monitoring Well / 10/5/2004		MMW004 / Monitoring Well / 6/24/2005	
Metals (mg/l)	**Background mg/l**	**Screening mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	--	0.2	--	--	--	--	--	--	--	--	<0.03 K	--
Antimony	--	0.006	--	--	--	--	--	--	--	--	--	--
Arsenic	0.00103	0.01	--	--	--	--	--	--	--	--	--	--
Barium	--	2	--	--	--	--	--	--	--	--	--	--
Beryllium	--	0.004	--	--	--	--	--	--	--	--	--	--
Boron	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.000401	0.005	<0.0002 K	--	<0.0002 K	--	<0.0002 K	--	<0.0001 K	--	<0.0001 K	--
Chromium, Total	0.00604	0.1	<0.0002 K	--	<0.0002 K	--	<0.0002 K	--	**0.0002 J,K,B**	--	**0.0008 J,K,B**	--
Cobalt	0.000436	--	--	--	--	--	--	--	--	--	--	--
Copper	--	1.3	--	--	--	--	--	--	--	--	--	--
Iron	--	0.3	--	--	--	--	--	--	--	--	**0.41 J,K,B**	--
Lead	0.00146	0.015	--	--	--	--	--	--	--	--	--	--
Manganese	0.435	0.05	--	--	--	--	--	--	--	--	**0.0134 J,K,B**	--
Mercury	--	0.002	--	--	--	--	--	--	--	--	--	--
Molybdenum	0.0239	--	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	**0.0008 J,K,B**	--	**0.0005 J,K,B**	--	**0.00065 J,K,B**	--	**0.0014 J,K,B**	--	<0.0006 K	--
Selenium	0.00278	0.05	<0.001	--	<0.001	--	<0.001	--	<0.001	--	**0.001 J,B**	--
Silver	--	0.1	--	--	--	--	--	--	--	--	--	--
Thallium	0.0002	0.002	--	--	--	--	--	--	--	--	--	--
Uranium	--	0.03	--	--	--	--	--	--	--	--	--	--
Vanadium	0.0138	--	**0.0014 J,K,B**	--	**0.0013 J,K,B**	--	**0.00133 J,K,B**	--	**0.00059 J,K,B**	--	**0.0019 J,K,B**	--
Zinc	0.471	5	<0.004 K	--	<0.004 K	--	<0.004 K	--	**0.051 J,K,B**	--	**0.073 J,K,B**	--
Chemistry Parameters (mg/l)												
Alkalinity, Bicarbonate	--	--	--	**141**	--	**141**	--	**141**	--	**134**	--	**156**
Alkalinity, Carbonate	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0
Alkalinity, Hydroxide (as CaCO3)	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0
Alkalinity, Total (as CaCO3)	--	--	--	**141**	--	**141**	--	**141**	--	**134**	--	**156**
Calcium	--	--	**75.8 J,K,B**	--	**75.8 J,K,B**	--	**75.93 J,K,B**	--	**69.8 J,K,B**	--	**70.6 J,K,B**	--
Chloride (as Cl)	--	250	**67**	--	**67**	--	**66.7**	--	**63.8**	--	**56**	--
Fluoride	--	4	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--	--
Magnesium	--	--	**26.4 J,K,B**	--	**26.2 J,K,B**	--	**26.37 J,K,B**	--	**36.9 J,K,B**	--	**25.4 J,K,B**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--	**1.33**
Phosphorus, total orthophosphate (as PO4)	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	--	--	**3.6 J,K,B**	--	**3.6 J,K,B**	--	**3.6 J,K,B**	--	**1.6 J,K,B**	--	**3.3 J,K,B**	--
Sodium	--	--	**45.8 J,K,B**	--	**46.4 J,K,B**	--	**46 J,K,B**	--	**8.6 J-,K**	--	**45 J,K,B**	--
Sulfate (as SO4)	--	250	**137**	--	**124**	--	**131.7**	--	**137**	--	**122**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	--	--	--	--	--
Total dissolved solids (Residue, filterable)	--	500	--	--	--	--	--	--	--	--	--	--
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-7

SUMMARY OF GROUNDWATER RESULTS - HENRY SITE
P4 RI/FS
(Page 5 of 20)

Location Identification Location Type Date Collected			MMW004 Dup Monitoring Well 6/24/2005		MMW004 Triplicate Monitoring Well 6/24/2005		MMW004 Average Monitoring Well 6/24/2005		MMW004 Monitoring Well 10/30/2005		MMW004 Dup Monitoring Well 10/30/2005		MMW004 Triplicate Monitoring Well 10/30/2005	
Analyte/Methods (Units)														
Metals (mg/l)	**Background mg/l**	**Screening mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	--	0.2	<0.03 K	--	<0.03 K	--	<0.03 K	--	<0.03 K	--	**0.04 J,K,B**	--	<0.03 K	--
Antimony	--	0.006	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.00103	0.01	--	--	--	--	--	--	--	--	--	--	--	--
Barium	--	2	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	0.004	--	--	--	--	--	--	--	--	--	--	--	--
Boron	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.000401	0.005	<0.0001 K	--	<0.0001 K	--	<0.0001 K	--	<0.0001 K	<0.05 K	<0.0001 K	<0.1 K	<0.0001 K	<0.1 K
Chromium, Total	0.00604	0.1	**0.0008 J,K,B**	--	**0.0009 J,K,B**	--	**0.00083 J,K,B**	--	0.0004 UB,K	<0.05 K	0.0005 UB,K	<0.1 K	0.0005 UB,K	<0.1 K
Cobalt	0.000436	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	1.3	--	--	--	--	--	--	--	--	--	--	--	--
Iron	--	0.3	**0.42 J,K,B**	--	**0.42 J,K,B**	--	**0.417 J,K,B**	--	<0.02 K	**0.7 J,K,B**	<0.02 K	**0.5 J,K,B**	<0.02 K	**0.7 J,K,B**
Lead	0.00146	0.015	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	0.435	0.05	**0.0133 J,K,B**	--	**0.0133 J,K,B**	--	**0.01333 J,K,B**	--	**0.003 J+,K,B**	<0.3 K	**0.0028 J+,K,B**	<0.5 K	**0.0026 J+,K,B**	<0.5 K
Mercury	--	0.002	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	0.0239	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	<0.0006 K	--	<0.0006 K	--	<0.0006 K	--	<0.0006 K	<0.3 K	<0.0006 K	<0.6 K	<0.0006 K	<0.6 K
Selenium	0.00278	0.05	**0.001 J,B**	--	**0.002 J,B**	--	**0.0013 J,B**	--	**0.002 J,B**	<0.001	**0.001 J,B**	<0.001	**0.001 J,B**	<0.001
Silver	--	0.1	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.0002	0.002	--	--	--	--	--	--	--	--	--	--	--	--
Uranium	--	0.03	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	0.0138	--	**0.0019 J,K,B**	--	**0.0019 J,K,B**	--	**0.0019 J,K,B**	--	**0.0018 J,K,B**	<0.1 K	**0.0018 J,K,B**	<0.2 K	**0.0019 J,K,B**	<0.2 K
Zinc	0.471	5	**0.072 J,K,B**	--	**0.072 J,K,B**	--	**0.0723 J,K,B**	--	**0.04 J,K,B**	**0.284 J,K,B**	**0.038 J,K,B**	**0.617 J,K,B**	**0.04 J,K,B**	**0.529 J,K,B**
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	**156**	--	**156**	--	**156**	--	**166**	--	**166**	--	**167**
Alkalinity, Carbonate	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0
Alkalinity, Hydroxide (as CaCO3)	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0
Alkalinity, Total (as CaCO3)	--	--	--	**156**	--	**156**	--	**156**	--	**166**	--	**166**	--	**167**
Calcium	--	--	**71.4 J,K,B**	--	**72.1 J,K,B**	--	**71.37 J,K,B**	--	**77.3 J,K,B**	--	**77.4 J,K,B**	--	**75.4 J,K,B**	--
Chloride (as Cl)	--	250	**56**	--	**58**	--	**56.7**	--	**56**	--	**55 J**	--	**61 J**	--
Fluoride	--	4	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Magnesium	--	--	**25.6 J,K,B**	--	**25.9 J,K,B**	--	**25.63 J,K,B**	--	**27.5 J,K,B**	--	**27.5 J,K,B**	--	**26.7 J,K,B**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	**1.4**	--	**1.4**	--	**1.377**	--	**1.37**	--	**1.33**	--	**1.35**
Phosphorus, total orthophosphate (as PO4)	--	--	--	--	--	--	--	--	**0.08 J**	--	**0.08 J**	--	**0.08 J**	--
Potassium	--	--	**3.5 J,K,B**	--	**3.5 J,K,B**	--	**3.43 J,K,B**	--	**3.6 J,K,B**	--	**3.6 J,K,B**	--	**3.5 J,K,B**	--
Sodium	--	--	**45.4 J,K,B**	--	**45.8 J,K,B**	--	**45.4 J,K,B**	--	**45.3 J,K,B**	--	**45.5 J,K,B**	--	**43.9 J,K,B**	--
Sulfate (as SO4)	--	250	**121**	--	**126**	--	**123**	--	**125**	--	**124 J**	--	**135 J**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total dissolved solids (Residue, filterable)	--	500	--	--	--	--	--	--	--	--	--	--	--	--
Total organic carbon	--	--	--	--	--	--	--	--	--	**1.0 J,B**	--	<1.0	--	**1.0 J,B**

TABLE B-7

SUMMARY OF GROUNDWATER RESULTS - HENRY SITE
P4 RI/FS

Analyte/Methods (Units)	Location Identification / Location Type / Date Collected		MMW004 Average Monitoring Well 10/30/2005		MMW004 Monitoring Well 5/14/2006		MMW004 Dup Monitoring Well 5/14/2006		MMW004 Triplicate Monitoring Well 5/14/2006		MMW004 Average Monitoring Well 5/14/2006		MMW004 Monitoring Well 9/15/2007	
Metals (mg/l)	Background mg/l	Screening mg/l	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Aluminum	--	0.2	0.04 J,K	--	<0.03 K	--	<0.03 K	--	<0.03 K	--	<0.03 K	--	<0.03 K	<0.03 K
Antimony	--	0.006	--	--	<0.0004 K	--	<0.0004 K	--	<0.0004 K	--	<0.0004 K	--	<0.0004 K	<0.0004 K
Arsenic	0.00103	0.01	--	--	<0.0005 K	--	<0.0005 K	--	<0.0005 K	--	<0.0005 K	--	<0.0005 K	0.0006 J,K,B
Barium	--	2	--	--	0.064 J,K,B	--	0.063 J,K,B	--	0.065 J,K,B	--	0.064 J,K,B	--	0.064 J,K,B	0.067 J,K,B
Beryllium	--	0.004	--	--	<0.002 K	--	<0.002 K	--	<0.002 K	--	<0.002 K	--	<0.002 K	<0.002 K
Boron	--	--	--	--	--	--	--	--	--	--	--	--	0.03 J,K,B	0.04 J,K,B
Cadmium	0.000401	0.005	<0.0001 K	<0.1 K	<0.0001 K	<0.0001 K	<0.0001 K	<0.0001 K	<0.0001 K	<0.0001 K	<0.0001 K	<0.0001 K	<0.0001 K	<0.0001 K
Chromium, Total	0.00604	0.1	0.00047 UB,K	<0.1 K	0.0005 J,K,B	0.0017 J,K,B	0.0005 J,K,B	0.0027 J,K,B	0.0004 J,K,B	0.0021 J,K,B	0.00047 J,K,B	0.00217 J,K,B	<0.0001 K	0.0012 J,K,B
Cobalt	0.000436	--	--	--	<0.01 K	--	0.01 UB,K	--	0.01 UB,K	--	0.01 UB,K	--	<0.01 K	<0.01 K
Copper	--	1.3	--	--	<0.01 K	--	<0.01 K	--	<0.01 K	--	<0.01 K	--	<0.01 K	<0.01 K
Iron	--	0.3	<0.02 K	0.63 J,K,B	0.03 J,K,B	--	0.04 J,K,B	--	0.03 J,K,B	--	0.033 J,K,B	--	<0.02 K	0.69 J,K,B
Lead	0.00146	0.015	--	--	<0.0001 K	--	<0.0001 K	--	<0.0001 K	--	<0.0001 K	--	<0.0001 K	0.0003 UB,K
Manganese	0.435	0.05	0.0028 J+,K,B	<0.5 K	0.0025 J,K,B	--	0.0024 J,K,B	--	0.0024 J,K,B	--	0.00243 J,K,B	--	0.0019 J,K,B	0.0097 J,K,B
Mercury	--	0.002	--	--	<0.0002	--	<0.0002	--	<0.0002	--	<0.0002	--	<0.0002	<0.0002
Molybdenum	0.0239	--	--	--	<0.01 K	--	<0.01 K	--	<0.01 K	--	<0.01 K	--	<0.01 K	<0.01 K
Nickel	--	--	<0.0006 K	<0.6 K	0.0011 J,K,B	0.0015 J,K,B	0.0012 J,K,B	0.0016 J,K,B	0.001 J,K,B	0.0015 J,K,B	0.0011 J,K,B	0.00153 J,K,B	0.0016 J,K,B	0.0012 J,K,B
Selenium	0.00278	0.05	0.0013 J,B	<0.001	0.001 J,B	0.001 J,B	0.001 J,B	0.002 J,B	0.001 J,B	0.001 J,B	0.001 J,B	0.0013 J,B	0.002 J,B	0.002 J,B
Silver	--	0.1	--	--	<0.01 UJ,K	--	<0.01 UJ,K	--	<0.01 UJ,K	--	<0.01 UJ,K	--	<0.01 UJ,K	<0.01 K
Thallium	0.0002	0.002	--	--	<0.0001 K	--	<0.0001 K	--	<0.0001 K	--	<0.0001 K	--	0.0001 UB,K	<0.0001 K
Uranium	--	0.03	--	--	0.0011 J,K,B	--	0.0011 J,K,B	--	0.0011 J,K,B	--	0.0011 J,K,B	--	0.0011 J,K,B	0.0012 J,K,B
Vanadium	0.0138	--	0.00183 J,K,B	<0.2 K	0.002 J,K,B	0.0033 J,K,B	0.002 J,K,B	0.0034 J,K,B	0.002 J,K,B	0.0033 J,K,B	0.002 J,K,B	0.00333 J,K,B	0.0017 J,K,B	0.0022 J,K,B
Zinc	0.471	5	0.0393 J,K,B	0.4767 J,K,B	0.043 J,K,B	0.143 J,K,B	0.042 J,K,B	0.132 J,K,B	0.039 J,K,B	0.139 J,K,B	0.0413 J,K,B	0.138 J,K,B	0.009 J,K,B	0.006 J,K,B
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	166.3	--	189	--	189	--	185	--	187.7	--	195
Alkalinity, Carbonate	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0
Alkalinity, Hydroxide (as CaCO3)	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0
Alkalinity, Total (as CaCO3)	--	--	--	166.3	--	189	--	189	--	185	--	187.7	--	195
Calcium	--	--	76.7 J,K,B	--	72.5 J,K,B	--	72.7 J,K,B	--	73.5 J,K,B	--	72.9 J,K,B	--	73.2 J,K,B	72.9 J,K,B
Chloride (as Cl)	--	250	57.3 J	--	51.3	--	51.5	--	51.4	--	51.4	--	50.5	--
Fluoride	--	4	--	--	--	--	--	--	--	--	--	--	0.4 J,B	--
Hardness (as CaCO3)	--	--	--	--	296	--	296	--	296	--	296	--	292	--
Magnesium	--	--	27.23 J,K,B	--	27.8 J,K,B	--	27.7 J,K,B	--	27.4 J,K,B	--	27.63 J,K,B	--	26.6 J,K,B	26.5 J,K,B
Nitrogen, Kjeldahl, Total	--	--	--	--	--	<0.1	--	<0.1	--	<0.1	--	<0.1	--	<0.1
Nitrogen, nitrate-nitrite	--	--	--	1.35	--	1.54	--	1.46	--	2.12	--	1.707	--	1.27 J-
Phosphorus, total orthophosphate (as PO4)	--	--	0.08 J	--	0.08 J	--	0.09 J	--	0.08 J	--	0.083 J	--	0.08 J-	--
Potassium	--	--	3.57 J,K,B	--	3.6 J,K,B	--	3.5 J,K,B	--	3.5 J,K,B	--	3.53 J,K,B	--	3.4 J,K,B	3.4 J,K,B
Sodium	--	--	44.9 J,K,B	--	45.4 J,K,B	--	45.2 J,K,B	--	45.6 J,K,B	--	45.4 J,K,B	--	45.4 J,K,B	47.9 J,K,B
Sulfate (as SO4)	--	250	128 J	--	116	--	117	--	115	--	116	--	129	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	<5.0	--	<5.0	--	<5.0	--	<5.0	--	<5.0
Total dissolved solids (Residue, filterable)	--	500	--	--	490	--	490	--	470	--	483.3	--	460 J-	--
Total organic carbon	--	--	--	1.0 J,B	--	4.0 J,B	--	2.0 J,B	--	4.0 J,B	--	3.3 J,B	--	--

TABLE B-7

SUMMARY OF GROUNDWATER RESULTS - HENRY SITE
P4 RI/FS
(Page 7 of 20)

Analyte/Methods (Units)	Background	Screening	Location Identification: MMW004 Location Type: Monitoring Well Date Collected: 5/20/2008		MMW004 Monitoring Well 9/22/2008		MMW004 Monitoring Well 6/1/2009		MMW010 Monitoring Well 10/17/2007		MMW010 Monitoring Well 5/15/2008		MMW010 Monitoring Well 10/6/2008	
Metals (mg/l)	**mg/l**	**mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	--	0.2	<0.03 K	<0.03 K	<0.05	<0.05	--	--	**0.03 J,K,B**	0.06 UB,K	**0.05 J+,K,B**	**0.12 J,K,B**	<0.05	<0.05
Antimony	--	0.006	--	--	--	--	--	--	<0.0004 K	<0.0004 K	<0.0004 K	<0.0004 K	--	--
Arsenic	0.00103	0.01	--	--	--	--	--	--	<0.0005 K	<0.0005 K	**0.0036 J,K,B**	**0.0043 J,K,B**	--	--
Barium	--	2	--	--	--	--	--	--	**0.164 J,K,B**	**0.164 J,K,B**	**0.099 J,K,B**	**0.101 J,K,B**	--	--
Beryllium	--	0.004	--	--	--	--	--	--	<0.002 K	<0.002 K	<0.002 K	<0.002 K	--	--
Boron	--	--	--	--	--	--	--	--	<0.01 K	**0.01 J,K,B**	**0.03 J,K,B**	**0.02 J,K,B**	--	--
Cadmium	0.000401	0.005	<0.0001 K	<0.0001 K	<0.000125	<0.000125	--	--	**0.0001 J,K,B**	**0.0001 J,K,B**	**0.0021 J,K,B**	**0.0021 J,K,B**	**0.00544**	**0.00529**
Chromium, Total	0.00604	0.1	--	--	**0.00223**	**0.00242**	--	--	<0.002 K	<0.002 K	**0.0157 J,K,B**	**0.003 J,K,B**	**0.00414**	**0.0038**
Cobalt	0.000436	--	--	--	--	--	--	--	<0.01 K	**0.01 J,K,B**	<0.01 K	<0.01 K	--	--
Copper	--	1.3	--	--	--	--	--	--	<0.01 K	<0.01 K	<0.01 K	<0.01 K	--	--
Iron	--	0.3	**0.02 J,K,B**	**0.43 J,K,B**	**0.0374 F**	**1.07**	--	--	**0.05 J,K,B**	**0.36 J,K,B**	<0.02 K	**0.32 J,K,B**	**0.0357 F**	**0.106**
Lead	0.00146	0.015	--	--	--	--	--	--	<0.0001 K	**0.0001 J,K,B**	<0.0001 K	**0.0002 J,K,B**	--	--
Manganese	0.435	0.05	**0.0031 J,K,B**	**0.0082 J,K,B**	**0.00708**	**0.0174**	--	--	**3.57 J,K,B**	**3.39 J,K,B**	**0.872 J,K,B**	**0.869 J,K,B**	**1.12**	**1.11**
Mercury	--	0.002	--	--	--	--	--	--	0.0003 UB	<0.0002	<0.0002	<0.0002	--	--
Molybdenum	0.0239	--	--	--	--	--	--	--	<0.01 K	<0.01 K	**0.02 J,K,B**	<0.01 K	--	--
Nickel	--	--	**0.0025 J,K,B**	0.0014 UB,K	**0.00223 F**	**0.00228 F**	--	--	**0.0136 J,K,B**	**0.0129 J,K,B**	**0.0666 J,K,B**	**0.0672 J,K,B**	**0.125**	**0.124**
Selenium	0.00278	0.05	**0.002 J,B**	**0.002 J,B**	**0.00244**	**0.00254**	--	**0.00273**	<0.001	<0.001	**0.1**	**0.1**	**0.0188**	**0.0182**
Silver	--	0.1	--	--	--	--	--	--	**0.02 J-,B,K**	<0.01 K	<0.01 UJ,K	<0.01 K	--	--
Thallium	0.0002	0.002	--	--	--	--	--	--	<0.0001 K	<0.0001 K	<0.0001 K	**0.0008 J,K,B**	--	--
Uranium	--	0.03	--	--	--	--	--	--	**0.0021 J,K,B**	**0.002 J,K,B**	**0.0118 J,K,B**	**0.0126 J,K,B**	--	--
Vanadium	0.0138	--	**0.0017 J,K,B**	**0.0013 B,K**	<0.005	<0.005	--	--	**0.007 J,K,B**	<0.0002 K	**0.0067 J,K,B**	**0.0078 J,K,B**	<0.005	<0.005
Zinc	0.471	5	**0.003 J,K,B**	<0.002 K	**0.0162 F**	**0.0156 F**	--	--	**0.017 J,K,B**	**0.015 J,K,B**	**0.196 J,K,B**	**0.204 J,K,B**	**0.173**	**0.175**
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	**181**	--	--	--	--	--	**170**	--	**322**	--	--
Alkalinity, Carbonate	--	--	--	<2.0	--	--	--	--	--	<2.0	--	<2.0	--	--
Alkalinity, Hydroxide (as CaCO3)	--	--	--	<2.0	--	--	--	--	--	<2.0	--	<2.0	--	--
Alkalinity, Total (as CaCO3)	--	--	--	**181**	**191**	--	--	--	--	**170**	--	**322**	**453**	--
Calcium	--	--	**72.5 J,K,B**	**74.7 J,K,B**	**64.3**	--	--	--	**55.3 J,K,B**	**54 J,K,B**	**199 J,K,B**	**196 J,K,B**	**258**	--
Chloride (as Cl)	--	250	**49.7**	--	**50.1**	--	--	--	**11.8**	--	**7.8**	--	**5.99**	--
Fluoride	--	4	--	--	--	--	--	--	**0.2 J,B**	--	**0.2 J,B**	--	--	--
Hardness (as CaCO3)	--	--	**291**	**298**	**260**	--	--	--	**193**	--	**719**	**714**	**946**	--
Magnesium	--	--	**26.8 J,K,B**	**27 J,K,B**	**24**	--	--	--	**13.4 J,K,B**	**13.2 J,K,B**	**53.9 J,K,B**	**54.4 J,K,B**	**73.2**	--
Nitrogen, Kjeldahl, Total	--	--	--	**0.2 J-,B**	--	--	--	--	--	**0.5 J,B**	--	**0.6 B**	--	--
Nitrogen, nitrate-nitrite	--	--	--	**1.28**	--	--	--	--	--	**0.02 J,B**	--	**0.93 J+**	--	--
Phosphorus, total orthophosphate (as PO4)	--	--	**0.11 J-**	--	--	--	--	--	--	--	**0.1 J-**	--	--	--
Potassium	--	--	**3.6 J,K,B**	**3.5 J,K,B**	**3.58**	--	--	--	**3.0 J,K,B**	**2.8 J,K,B**	**6.5 J,K,B**	**5.9 J,K,B**	**2.66**	--
Sodium	--	--	**47.4 J,K,B**	--	**47**	--	--	--	**16.5 J,K,B**	**16.7 J,K,B**	**25.4 J,K,B**	**25.4 J,K,B**	**23.3**	--
Sulfate (as SO4)	--	250	**125**	--	**116**	--	**112**	--	**36.7**	--	**367 J-**	--	**534**	--
Suspended solids (Residue, non-filterable)	--	--	--	<5.0	--	**4.5 F**	--	--	--	<5.0	--	<5.0	--	<2.5
Total dissolved solids (Residue, filterable)	--	500	**460 J-**	--	--	**514**	--	**548**	**280 J-**	--	**940 J-**	--	--	**1260**
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-7

SUMMARY OF GROUNDWATER RESULTS - HENRY SITE
P4 RI/FS
(Page 8 of 20)

Analyte/Methods (Units)	Location Identification Location Type Date Collected		MMW010 Monitoring Well 6/4/2009		MMW010 Monitoring Well 9/23/2009		MMW010 Monitoring Well 5/23/2010		MMW010 Monitoring Well 9/17/2010		MMW010 Monitoring Well 5/14/2012		MMW010 Monitoring Well 4/25/2013	
Metals (mg/l)	**Background mg/l**	**Screening mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	--	0.2	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	0.006	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.00103	0.01	--	--	--	--	--	--	--	--	--	--	--	--
Barium	--	2	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	0.004	--	--	--	--	--	--	--	--	--	--	--	--
Boron	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.000401	0.005	--	--	--	--	--	**0.00448**	--	**0.00421**	--	**0.00628 D**	--	**0.00446**
Chromium, Total	0.00604	0.1	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	0.000436	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	1.3	--	--	--	--	--	--	--	--	--	--	--	--
Iron	--	0.3	--	--	--	--	--	--	--	--	--	--	--	--
Lead	0.00146	0.015	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	0.435	0.05	--	--	--	--	--	--	--	--	--	**0.133 D**	--	**0.0258**
Mercury	--	0.002	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	0.0239	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	0.00278	0.05	--	**0.0764**	--	**0.0191**	--	**0.105**	--	**0.0213**	--	**0.0976 D**	**0.225**	**0.219**
Silver	--	0.1	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.0002	0.002	--	--	--	--	--	--	--	--	--	--	--	--
Uranium	--	0.03	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	0.0138	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	0.471	5	--	--	--	--	--	--	--	--	--	--	--	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Carbonate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Hydroxide (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Total (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloride (as Cl)	--	250	--	--	--	--	--	--	--	--	--	--	--	--
Fluoride	--	4	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Magnesium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO4)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sulfate (as SO4)	--	250	**688**	--	**740**	--	**599**	--	**674**	--	**782 D**	--	**523 D**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total dissolved solids (Residue, filterable)	--	500	--	**1770**	--	**1420**	--	**1330**	--	**1280**	--	**1720**	--	**1110**
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-7

SUMMARY OF GROUNDWATER RESULTS - HENRY SITE
P4 RI/FS

Analyte/Methods (Units)		Location Identification Location Type Date Collected	MMW010 Monitoring Well 5/10/2014		MMW011 Monitoring Well 10/19/2007		MMW011 Monitoring Well 5/21/2008		MMW011 Monitoring Well 9/21/2008		MMW011 Monitoring Well 6/2/2009		MMW011 Monitoring Well 5/16/2010	
Metals (mg/l)	**Background mg/l**	**Screening mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	--	0.2	--	--	<0.03 K	**0.24 B,K**	<0.03 K	**0.19 J,K,B**	<0.05	<0.05	--	--	--	--
Antimony	--	0.006	--	--	<0.0004 K	<0.0004 K	--	--	--	--	--	--	--	--
Arsenic	0.00103	0.01	--	--	<0.0005 K	**0.0005 J,K,B**	--	--	--	--	--	--	--	--
Barium	--	2	--	--	**0.046 J,K,B**	**0.045 J,K,B**	--	--	--	--	--	--	--	--
Beryllium	--	0.004	--	--	<0.002 K	<0.002 K	--	--	--	--	--	--	--	--
Boron	--	--	--	--	**0.03 J,K,B**	**0.03 J,K,B**	--	--	--	--	--	--	--	--
Cadmium	0.000401	0.005	--	**0.00527**	**0.0006 J,K,B**	**0.0007 J,K,B**	**0.0007 J,K,B**	**0.001 J,K,B**	**0.000466 F**	**0.000439 F**	--	--	--	**0.000569 J**
Chromium, Total	0.00604	0.1	--	--	**0.0002 J,K,B**	**0.0017 J,K,B**	--	--	**0.0025**	**0.00274**	--	--	--	--
Cobalt	0.000436	--	--	--	<0.01 K	<0.01 K	--	--	--	--	--	--	--	--
Copper	--	1.3	--	--	<0.01 K	<0.01 K	--	--	--	--	--	--	--	--
Iron	--	0.3	--	--	<0.02 K	**0.42 J,K,B**	<0.02 K	**0.34 J,K,B**	**0.0263 F**	<0.025	--	--	--	--
Lead	0.00146	0.015	--	--	<0.0001 K	**0.0004 J,K,B**	--	--	--	--	--	--	--	--
Manganese	0.435	0.05	--	**0.0256**	**0.0328 J,K,B**	**0.0343 J,K,B**	**0.0081 J,K,B**	**0.0741 J,K,B**	**0.000995 F**	**0.00201**	--	--	--	--
Mercury	--	0.002	--	--	<0.0002	<0.0002	--	--	--	--	--	--	--	--
Molybdenum	0.0239	--	--	--	<0.01 K	<0.01 K	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	**0.0049 J,K,B**	**0.0091 J,K,B**	**0.007 J,K,B**	**0.111 J,K,B**	**0.00727**	**0.00682**	--	--	--	--
Selenium	0.00278	0.05	**0.171 J**	**0.166 J**	<0.001	<0.001	<0.001	<0.001	**0.00129 J**	**0.000876 F,J**	--	**0.00206**	--	**0.00153**
Silver	--	0.1	--	--	<0.01 UJ,K	<0.01 K	--	--	--	--	--	--	--	--
Thallium	0.0002	0.002	--	--	**0.0002 J,K,B**	**0.0002 J,K,B**	--	--	--	--	--	--	--	--
Uranium	--	0.03	--	--	**0.0018 J,K,B**	**0.0018 J,K,B**	--	--	--	--	--	--	--	--
Vanadium	0.0138	--	--	--	**0.0042 J,K,B**	**0.0125 J+,K**	**0.0036 J,K,B**	**0.0092 J,K,B**	<0.005	<0.005	--	--	--	--
Zinc	0.471	5	--	--	**0.027 J,K,B**	**0.061 J,K,B**	**0.027 J,K,B**	**0.057 J,K,B**	**0.0287**	**0.0294**	--	--	--	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	--	--	**196**	--	**191**	--	--	--	--	--	--
Alkalinity, Carbonate	--	--	--	--	--	<2.0	--	<2.0	--	--	--	--	--	--
Alkalinity, Hydroxide (as CaCO3)	--	--	--	--	--	<2.0	--	<2.0	--	--	--	--	--	--
Alkalinity, Total (as CaCO3)	--	--	--	--	--	**196**	--	**191**	**205**	--	--	--	--	--
Calcium	--	--	--	--	**70.3 J,K,B**	**70 J,K,B**	**68.1 J-,K**	**70.2 J-,K**	**61.6**	--	--	--	--	--
Chloride (as Cl)	--	250	--	--	**47.5**	--	**47.3**	--	**47.1 J-**	--	--	--	--	--
Fluoride	--	4	--	--	**0.6**	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	--	--	**281**	--	**278**	**283**	**250**	--	--	--	--	--
Magnesium	--	--	--	--	**25.6 J,K,B**	**25.8 J,K,B**	**26.1 J,K,B**	**26.2 J,K,B**	**23.3**	--	--	--	--	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	<0.1	--	**0.2 J-,B**	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	**0.15**	--	**0.22**	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO4)	--	--	--	--	**0.04 J-,B**	--	**0.11 J-**	--	--	--	--	--	--	--
Potassium	--	--	--	--	**3.3 J,K,B**	**3.1 J,K,B**	**3.1 J,K,B**	**2.9 J,K,B**	**3.07**	--	--	--	--	--
Sodium	--	--	--	--	**42.2 J,K,B**	**44.1 J,K,B**	**43.4 J,K,B**	--	**44.2**	--	--	--	--	--
Sulfate (as SO4)	--	250	**695 D**	--	**98.4**	--	**96.1**	--	**89**	--	**96.8**	--	**87.7**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	**6.0 J,B**	--	**5.0 J,B**	--	**4.5 F**	--	--	--	--
Total dissolved solids (Residue, filterable)	--	500	--	**1320**	**420 J-**	--	**420 J-**	--	--	**426**	--	**450**	--	**438**
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-7

SUMMARY OF GROUNDWATER RESULTS - HENRY SITE
P4 RI/FS
(Page 10 of 20)

Analyte/Methods (Units)	Location Identification / Location Type / Date Collected		MMW011 Monitoring Well 5/13/2012		MMW011 Monitoring Well 5/15/2013		MMW011 Monitoring Well 5/10/2014		MMW014 Monitoring Well 9/17/2007		MMW014 Monitoring Well 5/13/2008		MMW014 Monitoring Well 9/21/2008	
Metals (mg/l)	**Background mg/l**	**Screening mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	--	0.2	--	--	--	--	--	--	0.12 UB,K	0.12 UB,K	<0.03 K	**0.07 J-,B,K**	<0.05	<0.05
Antimony	--	0.006	--	--	--	--	--	--	<0.0004 K	<0.004 K	<0.0004 K	<0.0004 K	--	--
Arsenic	0.00103	0.01	--	--	--	--	--	--	**0.0014 J,K,B**	**0.0012 J,K,B**	**0.0006 J-,B,K**	0.001 UB,K	--	--
Barium	--	2	--	--	--	--	--	--	**0.291 J,K,B**	**0.288 J,K,B**	**0.18 J,K,B**	**0.195 J,K,B**	--	--
Beryllium	--	0.004	--	--	--	--	--	--	<0.002 K	<0.002 K	<0.002 K	<0.002 K	--	--
Boron	--	--	--	--	--	--	--	--	**0.01 J,K,B**	**0.02 J,K,B**	<0.01 K	<0.01 K	--	--
Cadmium	0.000401	0.005	--	<0.0006 D	--	**0.000568 F**	--	**0.000694**	<0.0001 K	**0.0001 J,K,B**	**0.0001 J,K,B**	**0.0001 J,K,B**	<0.000125	<0.000125
Chromium, Total	0.00604	0.1	--	--	--	--	--	--	<0.0001 K	<0.0005 K	<0.0001 K	<0.0001 K	**0.00209**	**0.00206**
Cobalt	0.000436	--	--	--	--	--	--	--	<0.01 K	<0.01 K	<0.01 K	<0.01 K	--	--
Copper	--	1.3	--	--	--	--	--	--	<0.01 K	<0.01 K	<0.01 K	<0.01 K	--	--
Iron	--	0.3	--	--	--	--	--	--	**0.15 J,K,B**	**0.29 J,K,B**	**0.04 J,K,B**	**0.7 J,K,B**	**0.0426 F**	**0.526**
Lead	0.00146	0.015	--	--	--	--	--	--	0.0001 UB,K	0.0002 UB,K	**0.0001 J,K,B**	**0.0008 J,K,B**	--	--
Manganese	0.435	0.05	--	**0.00339 F,D**	--	**0.00229**	--	**0.00146 F**	**0.995 J,K,B**	**0.947 J,K,B**	**0.252 J,K,B**	**0.254 J,K,B**	**0.367**	**0.391**
Mercury	--	0.002	--	--	--	--	--	--	<0.0002	<0.0002	<0.0002	<0.0002	--	--
Molybdenum	0.0239	--	--	--	--	--	--	--	<0.01 K	<0.01 K	<0.01 K	<0.01 K	--	--
Nickel	--	--	--	--	--	--	--	--	**0.017 J,K,B**	**0.0211 J,K,B**	**0.011 J+,K**	**0.013 J,K,B**	**0.0166**	**0.0172**
Selenium	0.00278	0.05	--	**0.00124 F,B**	**0.000855 F**	**0.000953 F**	**0.00072 F,J**	**0.00067 F,J**	<0.001	<0.001	<0.001	<0.001	**0.00227**	**0.00203**
Silver	--	0.1	--	--	--	--	--	--	<0.01 UJ,K	<0.01 K	<0.01 UJ,K	<0.01 K	--	--
Thallium	0.0002	0.002	--	--	--	--	--	--	0.0002 UB,K	**0.0009 J-,B,K**	<0.0001 K	<0.0001 K	--	--
Uranium	--	0.03	--	--	--	--	--	--	**0.0132 J,K,B**	**0.0128 J,K,B**	**0.01 J,K,B**	**0.0088 J,K,B**	--	--
Vanadium	0.0138	--	--	--	--	--	--	--	**0.0007 J,K,B**	**0.0006 J,K,B**	0.0009 UB,K	**0.0008 J,K,B**	<0.005	<0.005
Zinc	0.471	5	--	--	--	--	--	--	**0.006 J,K,B**	**0.005 J,K,B**	**0.005 J-,B,K**	0.004 UB,K	<0.005	**0.00637 F**
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	--	--	--	--	--	--	**526**	--	**332**	--	--
Alkalinity, Carbonate	--	--	--	--	--	--	--	--	--	<2.0	--	<2.0	--	--
Alkalinity, Hydroxide (as CaCO3)	--	--	--	--	--	--	--	--	--	<2.0	--	<2.0	--	--
Alkalinity, Total (as CaCO3)	--	--	--	--	--	--	--	--	--	**526**	--	**332**	**544**	--
Calcium	--	--	--	--	--	--	--	--	**144 J,K,B**	**144 J,K,B**	**111 J,K,B**	**111 J,K,B**	**129**	--
Chloride (as Cl)	--	250	--	--	--	--	--	--	**5.6**	--	**6.9**	--	**5.79**	--
Fluoride	--	4	--	--	--	--	--	--	**0.2 J-,B**	--	**0.1 J,B**	--	--	--
Hardness (as CaCO3)	--	--	--	--	--	--	--	--	**522**	--	**404**	**404**	**470**	--
Magnesium	--	--	--	--	--	--	--	--	**39.3 J,K,B**	**39 J,K,B**	**30.9 J,K,B**	**30.8 J,K,B**	**35.7**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	--	--	<0.1	--	<0.1	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	<0.02	--	**0.03 J,B**	--	--
Phosphorus, total orthophosphate (as PO4)	--	--	--	--	--	--	--	--	**0.03 J-,B**	--	**0.05 J-,B**	--	--	--
Potassium	--	--	--	--	--	--	--	--	**1.5 J,K,B**	**1.4 J,K,B**	**0.9 J,K,B**	**0.8 J,K,B**	**1.36**	--
Sodium	--	--	--	--	--	--	--	--	**20 J,K,B**	**19.8 J,K,B**	**15.9 J,K,B**	**15.8 J,K,B**	**21.2**	--
Sulfate (as SO4)	--	250	**69 J+**	--	**80.3 D**	--	**119 D**	--	**35.8**	--	**61.9**	--	**36.9**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	--	--	<5.0	--	**6.0 J,B**	--	**5.0**
Total dissolved solids (Residue, filterable)	--	500	--	**320**	--	**412**	--	**458**	**580 J-**	--	**450 J-**	--	--	**578**
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-7

SUMMARY OF GROUNDWATER RESULTS - HENRY SITE
P4 RI/FS
(Page 11 of 20)

Analyte/Methods (Units)		Location Identification / Location Type / Date Collected	MMW014 Monitoring Well 6/3/2009		MMW019 Monitoring Well 9/17/2007		MMW019 Monitoring Well 5/14/2008		MMW019 Monitoring Well 9/22/2008		MMW019 Monitoring Well 6/2/2009		MMW022 Monitoring Well 9/19/2007	
Metals (mg/l)	**Background mg/l**	**Screening mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	--	0.2	--	--	0.09 UB,K	<0.03 K	<0.03 K	<0.03 K	<0.05	<0.05	--	--	<0.03 K	**0.22 J+,K**
Antimony	--	0.006	--	--	<0.0004 K	<0.0004 K	--	--	--	--	--	--	0.0005 UB,K	**0.0006 J,K,B**
Arsenic	0.00103	0.01	--	--	<0.0005 K	<0.0005 K	--	--	--	--	--	--	**0.0006 J,K,B**	**0.0006 J,K,B**
Barium	--	2	--	--	**0.04 J,K,B**	**0.039 J,K,B**	--	--	--	--	--	--	**0.034 J,K,B**	**0.036 J,K,B**
Beryllium	--	0.004	--	--	<0.002 K	<0.002 K	--	--	--	--	--	--	<0.002 K	<0.002 K
Boron	--	--	--	--	**0.04 J,K,B**	**0.04 J,K,B**	--	--	--	--	--	--	**0.01 J,K,B**	**0.02 J,K,B**
Cadmium	0.000401	0.005	--	--	<0.0001 K	<0.0001 K	<0.0001 K	<0.0002 K	<0.000125	<0.000125	--	--	<0.0001 K	<0.0001 K
Chromium, Total	0.00604	0.1	--	--	<0.0001 K	<0.0001 K	--	--	**0.00196 F**	**0.00234**	--	--	<0.0001 K	<0.0001 K
Cobalt	0.000436	--	--	--	<0.01 K	<0.01 K	--	--	--	--	--	--	<0.01 K	<0.01 K
Copper	--	1.3	--	--	<0.01 K	<0.01 K	--	--	--	--	--	--	<0.01 K	<0.01 K
Iron	--	0.3	--	--	<0.04 K	<0.02 K	<0.02 K	**0.03 J-,B,K**	<0.025	<0.025	--	--	<0.02 K	**0.18 B,K**
Lead	0.00146	0.015	--	--	<0.0001 K	<0.0001 K	--	--	--	--	--	--	0.0001 UB,K	**0.0002 J,K,B**
Manganese	0.435	0.05	--	--	**0.0083 J,K,B**	**0.0107 J,K,B**	<0.0005 K	**0.001 J-,B,K**	**0.00954**	**0.000547 F**	--	--	**0.0777 J,K,B**	**0.0966 J,K,B**
Mercury	--	0.002	--	--	**0.0003 J,B**	<0.0002	--	--	--	--	--	--	<0.0002	<0.0002
Molybdenum	0.0239	--	--	--	<0.01 K	<0.01 K	--	--	--	--	--	--	<0.01 K	<0.01 K
Nickel	--	--	--	--	**0.003 J,K,B**	**0.0045 J,K,B**	**0.0016 J,K,B**	<0.001 K	**0.00344 F**	**0.00284 F**	--	--	**0.0056 J,K,B**	**0.008 J,K,B**
Selenium	0.00278	0.05	--	**0.00173**	<0.001	<0.001	**0.005 J,B**	**0.004 J-,B**	**0.000665 F**	**0.000563 F**	--	**0.00541**	**0.017**	**0.017**
Silver	--	0.1	--	--	<0.01 UJ,K	<0.01 K	--	--	--	--	--	--	<0.01 UJ,K	<0.01 K
Thallium	0.0002	0.002	--	--	0.0001 UB,K	**0.0001 J-,B,K**	--	--	--	--	--	--	0.0001 UB,K	<0.0001 K
Uranium	--	0.03	--	--	**0.0012 J,K,B**	**0.0011 J,K,B**	--	--	--	--	--	--	**0.0018 J,K,B**	**0.0022 J,K,B**
Vanadium	0.0138	--	--	--	**0.0015 J,K,B**	**0.0013 J,K,B**	**0.0009 J,K,B**	<0.0004 K	<0.005	<0.005	--	--	0.0003 UB,K	0.0002 UB,K
Zinc	0.471	5	--	--	**0.002 J,K,B**	<0.002 K	**0.002 J,K,B**	**0.004 J,K,B**	<0.005	<0.005	--	--	<0.002 K	**0.002 J,K,B**
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	--	--	**163**	--	**125**	--	--	--	--	--	**234**
Alkalinity, Carbonate	--	--	--	--	--	<2.0	--	<2.0	--	--	--	--	--	<2.0
Alkalinity, Hydroxide (as CaCO3)	--	--	--	--	--	<2.0	--	<2.0	--	--	--	--	--	<2.0
Alkalinity, Total (as CaCO3)	--	--	--	--	--	**163**	--	**125**	**150**	--	--	--	--	**234**
Calcium	--	--	--	--	**85 J,K,B**	**84.8 J,K,B**	**28.1 J,K,B**	**53.8 J,K,B**	**76.9**	--	--	--	**148 J,K,B**	**150 J,K,B**
Chloride (as Cl)	--	250	--	--	**79.2**	--	**44.4**	--	**79.2**	--	--	--	**5.5**	--
Fluoride	--	4	--	--	**0.4 J-,B**	--	--	--	--	--	--	--	<0.1	--
Hardness (as CaCO3)	--	--	--	--	**323**	--	**110**	**210**	**299**	--	--	--	**490**	--
Magnesium	--	--	--	--	**27 J,K,B**	**26.7 J,K,B**	**9.6 J,K,B**	**18.4 J,K,B**	**26.1**	--	--	--	**29.1 J,K,B**	**28.9 J,K,B**
Nitrogen, Kjeldahl, Total	--	--	--	--	--	<0.1	--	0.3 UB	--	--	--	--	--	<0.1
Nitrogen, nitrate-nitrite	--	--	--	--	--	**0.08 J,B**	--	**0.41**	--	--	--	--	--	**0.67**
Phosphorus, total orthophosphate (as PO4)	--	--	--	--	**0.06 J-**	--	**0.06 J**	--	--	--	--	--	**0.01 J-,B**	--
Potassium	--	--	--	--	**3.0 J,K,B**	**3.2 J,K,B**	**1.2 J,K,B**	**2.4 J,K,B**	**3.31**	--	--	--	**1.1 J,K,B**	**0.8 J,K,B**
Sodium	--	--	--	--	**53.1 J,K,B**	**53.3 J,K,B**	**20.4 J,K,B**	--	**58.1**	--	--	--	**9.2 J,K,B**	**9.2 J,K,B**
Sulfate (as SO4)	--	250	**28.6**	--	**159**	--	**93.5**	--	**159**	--	**55.9**	--	**229**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	<5.0	--	<5.0	--	<2.5	--	--	--	<5.0 UJ
Total dissolved solids (Residue, filterable)	--	500	--	**350**	**520 J-**	--	**350 J-**	--	--	**554**	--	**308**	**600 J-**	--
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-7

SUMMARY OF GROUNDWATER RESULTS - HENRY SITE
P4 RI/FS

Analyte/Methods (Units)	Location Identification / Location Type / Date Collected		MMW022 Dup Monitoring Well 9/19/2007		MMW022 Triplicate Monitoring Well 9/19/2007		MMW022 Average Monitoring Well 9/19/2007		MMW022 Monitoring Well 5/19/2008		MMW022 Dup Monitoring Well 5/19/2008		MMW022 Triplicate Monitoring Well 5/19/2008	
Metals (mg/l)	**Background mg/l**	**Screening mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	--	0.2	<0.03 K	**0.24 J+,K**	<0.03 K	**0.21 J+,K**	<0.03 K	**0.223 J+,K**	<0.03 K	<0.03 K	<0.03 K	<0.03 K	<0.03 K	<0.03 K
Antimony	--	0.006	0.0005 UB,K	**0.0005 J,K,B**	0.0005 UB,K	**0.0005 J,K,B**	0.0005 UB,K	**0.00053 J,K,B**	--	--	--	--	--	--
Arsenic	0.00103	0.01	**0.0005 J,K,B**	<0.0005 K	**0.0006 J,K,B**	<0.0005 K	**0.00057 J,K,B**	**0.0006 K**	--	--	--	--	--	--
Barium	--	2	**0.034 J,K,B**	**0.041 J,K,B**	**0.034 J,K,B**	**0.037 J,K,B**	**0.034 J,K,B**	**0.038 J,K,B**	--	--	--	--	--	--
Beryllium	--	0.004	<0.002 K	<0.002 K	<0.002 K	<0.002 K	<0.002 K	<0.002 K	--	--	--	--	--	--
Boron	--	--	**0.01 J,K,B**	**0.02 J,K,B**	**0.01 J,K,B**	**0.02 J,K,B**	**0.01 J,K,B**	**0.02 J,K,B**	--	--	--	--	--	--
Cadmium	0.000401	0.005	<0.0001 K	<0.0001 K	<0.0001 K	<0.0001 K	<0.0001 K	<0.0001 K	<0.0001 K	<0.0001 K	<0.0001 K	<0.0001 K	<0.0001 K	<0.0001 K
Chromium, Total	0.00604	0.1	<0.0001 K	<0.0001 K	<0.0001 K	<0.0001 K	<0.0001 K	<0.0001 K	--	--	--	--	--	--
Cobalt	0.000436	--	<0.01 K	<0.01 K	<0.01 K	<0.01 K	<0.01 K	<0.01 K	--	--	--	--	--	--
Copper	--	1.3	<0.01 K	<0.01 K	<0.01 K	<0.01 K	<0.01 K	<0.01 K	--	--	--	--	--	--
Iron	--	0.3	<0.02 K	**0.16 B,K**	<0.02 K	**0.15 B,K**	<0.02 K	**0.163 K**	<0.02 K	<0.02 K	<0.02 K	<0.02 K	<0.02 K	<0.02 K
Lead	0.00146	0.015	<0.0001 K	**0.0002 J,K,B**	<0.0001 K	**0.0003 J,K,B**	0.0001 UB,K	**0.00023 J,K,B**	--	--	--	--	--	--
Manganese	0.435	0.05	**0.0776 J,K,B**	**0.0994 J,K,B**	**0.0765 J,K,B**	**0.107 J,K,B**	**0.07727 J,K,B**	**0.101 J,K,B**	**0.0019 J,K,B**	**0.0077 J,K,B**	**0.0017 J,K,B**	**0.0103 J,K,B**	**0.0018 J,K,B**	**0.0035 J,K,B**
Mercury	--	0.002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	--	--	--	--	--	--
Molybdenum	0.0239	--	0.01 UB,K	<0.01 K	<0.01 K	<0.01 K	0.01 UB,K	<0.01 K	--	--	--	--	--	--
Nickel	--	--	**0.0056 J,K,B**	**0.0082 J,K,B**	**0.0056 J,K,B**	**0.0082 J,K,B**	**0.0056 J,K,B**	**0.00813 J,K,B**	**0.0061 J,K,B**	**0.0036 J,K,B**	**0.0058 J,K,B**	**0.0029 J,K,B**	**0.0057 J,K,B**	**0.0021 J,K,B**
Selenium	0.00278	0.05	**0.016**	**0.018**	**0.016**	**0.017**	**0.0163**	**0.0173**	**0.018**	**0.017**	**0.018**	**0.017**	**0.018**	**0.017**
Silver	--	0.1	<0.01 UJ,K	<0.01 K	<0.01 UJ,K	<0.01 K	<0.01 UJ,K	<0.01 K	--	--	--	--	--	--
Thallium	0.0002	0.002	0.0001 UB,K	<0.0001 K	0.0001 UB,K	<0.0001 K	0.0001 UB,K	<0.0001 K	--	--	--	--	--	--
Uranium	--	0.03	**0.0019 J,K,B**	**0.0023 J,K,B**	**0.0018 J,K,B**	**0.0023 J,K,B**	**0.00183 J,K,B**	**0.00227 J,K,B**	--	--	--	--	--	--
Vanadium	0.0138	--	0.0003 UB,K	<0.0002 K	0.0003 UB,K	0.0004 UB,K	0.0003 UB,K	0.0003 UB,K	**0.0004 J,K,B**	<0.0002 K	**0.0003 J,K,B**	<0.0002 K	**0.0003 J,K,B**	<0.0002 K
Zinc	0.471	5	<0.002 K	**0.002 J,K,B**	<0.002 K	**0.002 J,K,B**	<0.002 K	**0.002 J,K,B**	<0.002 K	<0.002 K	**0.006 J,K,B**	**0.003 J,K,B**	<0.002 K	<0.002 K
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	**233**	--	**233**	--	**233.3**	--	**218**	--	**218**	--	**217**
Alkalinity, Carbonate	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0
Alkalinity, Hydroxide (as CaCO3)	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	<2.0
Alkalinity, Total (as CaCO3)	--	--	--	**233**	--	**233**	--	**233.3**	--	**218**	--	**218**	--	**217**
Calcium	--	--	**148 J,K,B**	**150 J,K,B**	**148 J,K,B**	**148 J,K,B**	**148 J,K,B**	**149.3 J,K,B**	**151 J,K,B**	**149 J,K,B**	**144 J,K,B**	**151 J,K,B**	**141 J,K,B**	**150 J,K,B**
Chloride (as Cl)	--	250	**5.5**	--	**5.5**	--	**5.5**	--	**5.8**	--	**5.6**	--	**5.8**	--
Fluoride	--	4	<0.1	--	<0.1	--	<0.1	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	**490**	--	**490**	--	**490**	--	**496**	**491**	**473**	**498**	**462**	**494**
Magnesium	--	--	**29.2 J,K,B**	**29 J,K,B**	**29.1 J,K,B**	**28.6 J,K,B**	**29.13 J,K,B**	**28.83 J,K,B**	**28.8 J,K,B**	**28.8 J,K,B**	**27.5 J,K,B**	**29.3 J,K,B**	**26.6 J,K,B**	**28.9 J,K,B**
Nitrogen, Kjeldahl, Total	--	--	--	**0.2 J,B**	--	<0.1	--	**0.2 J**	--	**1.8 J-**	--	**0.3 J-,B**	--	**0.3 J-,B**
Nitrogen, nitrate-nitrite	--	--	--	**0.69**	--	**0.69**	--	**0.683**	--	**0.78**	--	**0.97**	--	**0.92**
Phosphorus, total orthophosphate (as PO4)	--	--	**0.01 J-,B**	--	**0.01 J-,B**	--	**0.01 J-,B**	--	**0.03 J-,B**	--	**0.03 J-,B**	--	**0.03 J-,B**	--
Potassium	--	--	**1.1 J,K,B**	**1.0 J,K,B**	**1.2 J,K,B**	**0.8 J,K,B**	**1.13 J,K,B**	**0.87 J,K,B**	**1.0 J,K,B**	**1.0 J,K,B**	**1.0 J,K,B**	**1.0 J,K,B**	**1.0 J,K,B**	**1.0 J,K,B**
Sodium	--	--	**9.2 J,K,B**	**9.0 J,K,B**	**9.3 J,K,B**	**8.9 J,K,B**	**9.23 J,K,B**	**9.03 J,K,B**	**9.3 J,K,B**	--	**9.0 J,K,B**	--	**8.6 J,K,B**	--
Sulfate (as SO4)	--	250	**245**	--	**231**	--	**235**	--	**263**	--	**255**	--	**263**	--
Suspended solids (Residue, non-filterable)	--	--	--	<5.0 UJ	--	<5.0 UJ	--	<5.0 UJ	--	<5.0	--	<5.0	--	<5.0
Total dissolved solids (Residue, filterable)	--	500	**600 J-**	--	**600 J-**	--	**600 J-**	--	**650 J-**	--	**650 J-**	--	**660 J-**	--
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-7

SUMMARY OF GROUNDWATER RESULTS - HENRY SITE
P4 RI/FS

Analyte/Methods (Units)	Location Identification / Location Type / Date Collected		MMW022 Average Monitoring Well 5/19/2008		MMW022 Monitoring Well 9/22/2008		MMW022 Monitoring Well 6/2/2009		MMW022 Monitoring Well 5/22/2010		MMW022 Monitoring Well 5/16/2012		MMW022 Monitoring Well 4/25/2013	
Metals (mg/l)	**Background mg/l**	**Screening mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	--	0.2	<0.03 K	<0.03 K	<0.05	**0.322**	--	--	--	--	--	--	--	--
Antimony	--	0.006	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.00103	0.01	--	--	--	--	--	--	--	--	--	--	--	--
Barium	--	2	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	0.004	--	--	--	--	--	--	--	--	--	--	--	--
Boron	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.000401	0.005	<0.0001 K	<0.0001 K	<0.000125	<0.000125	--	--	--	<0.0003	--	<0.0006 D	--	<0.0003
Chromium, Total	0.00604	0.1	--	--	**0.00197 F**	**0.00288**	--	--	--	--	--	--	--	--
Cobalt	0.000436	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	1.3	--	--	--	--	--	--	--	--	--	--	--	--
Iron	--	0.3	<0.02 K	<0.02 K	<0.025	**0.291**	--	--	--	--	--	--	--	--
Lead	0.00146	0.015	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	0.435	0.05	**0.0018 J,K,B**	**0.00717 J,K,B**	**0.00118 F**	**0.0243**	--	--	--	--	--	**0.128 D**	--	**0.0248**
Mercury	--	0.002	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	0.0239	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	**0.00587 J,K,B**	**0.00287 J,K,B**	**0.00473**	**0.00521**	--	--	--	--	--	--	--	--
Selenium	0.00278	0.05	**0.018**	**0.017**	**0.017**	**0.0175**	--	**0.0206**	--	**0.0215**	--	**0.041 D**	**0.0443**	**0.0456**
Silver	--	0.1	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.0002	0.002	--	--	--	--	--	--	--	--	--	--	--	--
Uranium	--	0.03	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	0.0138	--	**0.00033 J,K,B**	<0.0002 K	<0.005	<0.005	--	--	--	--	--	--	--	--
Zinc	0.471	5	**0.006 J,K**	**0.003 J,K**	<0.005	<0.005	--	--	--	--	--	--	--	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	**217.7**	--	--	--	--	--	--	--	--	--	--
Alkalinity, Carbonate	--	--	--	<2.0	--	--	--	--	--	--	--	--	--	--
Alkalinity, Hydroxide (as CaCO3)	--	--	--	<2.0	--	--	--	--	--	--	--	--	--	--
Alkalinity, Total (as CaCO3)	--	--	--	**217.7**	**233**	--	--	--	--	--	--	--	--	--
Calcium	--	--	**145.3 J,K,B**	**150 J,K,B**	**137**	--	--	--	--	--	--	--	--	--
Chloride (as Cl)	--	250	**5.73**	--	**5.8**	--	--	--	--	--	--	--	--	--
Fluoride	--	4	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	**477**	**494.3**	**452**	--	--	--	--	--	--	--	--	--
Magnesium	--	--	**27.63 J,K,B**	**29 J,K,B**	**26.9**	--	--	--	--	--	--	--	--	--
Nitrogen, Kjeldahl, Total	--	--	--	**0.8 J-,B**	--	--	--	--	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	**0.89**	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO4)	--	--	**0.03 J-,B**	--	--	--	--	--	--	--	--	--	--	--
Potassium	--	--	**1.0 J,K,B**	**1.0 J,K,B**	**0.906 F**	--	--	--	--	--	--	--	--	--
Sodium	--	--	**8.97 J,K,B**	--	**9.32**	--	--	--	--	--	--	--	--	--
Sulfate (as SO4)	--	250	**260.3**	--	**239**	--	**246**	--	**257**	--	**251 D**	--	**283 D**	--
Suspended solids (Residue, non-filterable)	--	--	--	<5.0	--	**14**	--	--	--	--	--	--	--	--
Total dissolved solids (Residue, filterable)	--	500	**653.3 J-**	--	--	**618**	--	**706**	--	**618**	--	**672**	--	**682**
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-7

SUMMARY OF GROUNDWATER RESULTS - HENRY SITE
P4 RI/FS
(Page 14 of 20)

Analyte/Methods (Units)	Location Identification / Location Type / Date Collected		MMW022 Monitoring Well 5/10/2014		MMW023 Monitoring Well 10/19/2007		MMW023 Monitoring Well 5/18/2008		MMW023 Monitoring Well 9/22/2008		MMW023 Monitoring Well 6/1/2009		MMW023 Monitoring Well 5/21/2010	
Metals (mg/l)	Background mg/l	Screening mg/l	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Aluminum	--	0.2	--	--	**0.04 J,K,B**	<0.03 K	**0.05 J,K,B**	<0.03 K	<0.05	<0.05	--	--	--	--
Antimony	--	0.006	--	--	**0.0015 J,K,B**	**0.0017 J,K,B**	--	--	--	--	--	--	--	--
Arsenic	0.00103	0.01	--	--	**0.0042 J,K,B**	**0.0043 J,K,B**	--	--	--	--	--	--	--	--
Barium	--	2	--	--	**0.077 J,K,B**	**0.072 J,K,B**	--	--	--	--	--	--	--	--
Beryllium	--	0.004	--	--	<0.002 K	<0.002 K	--	--	--	--	--	--	--	--
Boron	--	--	--	--	**0.02 J,K,B**	**0.03 J,K,B**	--	--	--	--	--	--	--	--
Cadmium	0.000401	0.005	--	<0.0003	**0.0002 J,K,B**	**0.0007 J,K,B**	<0.0001 K	**0.0015 J,K,B**	<0.000125	**0.000765**	--	--	--	<0.0003
Chromium, Total	0.00604	0.1	--	--	<0.0001 K	0.001 UB,K	--	--	**0.00208**	**0.00214**	--	--	--	--
Cobalt	0.000436	--	--	--	<0.01 K	**0.01 J,K,B**	--	--	--	--	--	--	--	--
Copper	--	1.3	--	--	<0.01 K	<0.01 K	--	--	--	--	--	--	--	--
Iron	--	0.3	--	--	**0.5 J,K,B**	**0.61 J,K,B**	**4.37 J,K,B**	**4.97 J,K,B**	**3.71**	**4.13**	--	--	--	--
Lead	0.00146	0.015	--	--	<0.0001 K	**0.0006 J,K,B**	--	--	--	--	--	--	--	--
Manganese	0.435	0.05	--	**0.0116**	**0.952 J,K,B**	**0.936 J,K,B**	**0.717 J,K,B**	**0.698 J,K,B**	**0.724**	**0.656**	--	--	--	--
Mercury	--	0.002	--	--	<0.0002	<0.0002	--	--	--	--	--	--	--	--
Molybdenum	0.0239	--	--	--	**0.11 J,K,B**	**0.11 J,K,B**	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	**0.166 J,K,B**	**0.171 J,K,B**	**0.0185 J,K,B**	**0.0324 J,K,B**	**0.0151**	**0.0351**	--	--	--	--
Selenium	0.00278	0.05	**0.042 J**	**0.0438 J**	<0.001	**0.003 J,B**	<0.001	**0.004 J,B**	**0.000639 F**	**0.00389**	--	**0.017**	--	**0.0017**
Silver	--	0.1	--	--	**0.01 J-,B,K**	<0.01 K	--	--	--	--	--	--	--	--
Thallium	0.0002	0.002	--	--	**0.0009 J,K,B**	**0.0009 J,K,B**	--	--	--	--	--	--	--	--
Uranium	--	0.03	--	--	**0.0063 J,K,B**	**0.0064 J,K,B**	--	--	--	--	--	--	--	--
Vanadium	0.0138	--	--	--	**0.007 J,K,B**	**0.0094 J+,K**	<0.0002 K	**0.003 J,K,B**	<0.005	<0.005	--	--	--	--
Zinc	0.471	5	--	--	**0.328 J,K,B**	**0.344 J,K,B**	**0.007 J,K,B**	**0.104 J,K,B**	**0.0174 F**	**0.764**	--	--	--	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	--	--	**321**	--	**325**	--	--	--	--	--	--
Alkalinity, Carbonate	--	--	--	--	--	<2.0	--	<2.0	--	--	--	--	--	--
Alkalinity, Hydroxide (as CaCO3)	--	--	--	--	--	<2.0	--	<2.0	--	--	--	--	--	--
Alkalinity, Total (as CaCO3)	--	--	--	--	--	**321**	--	**325**	**338 J+**	--	--	--	--	--
Calcium	--	--	--	--	**118 J,K,B**	**110 J,K,B**	**115 J,K,B**	**116 J,K,B**	**101**	--	--	--	--	--
Chloride (as Cl)	--	250	--	--	**30.7**	--	**26 J,B**	--	**25.6**	--	--	--	--	--
Fluoride	--	4	--	--	**0.5 J,B**	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	--	--	**427**	--	**419**	**424**	**372**	--	--	--	--	--
Magnesium	--	--	--	--	**32.1 J,K,B**	**30.2 J,K,B**	**31.9 J,K,B**	**32.7 J,K,B**	**29.4**	--	--	--	--	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	**0.9 J-**	--	**0.7 B**	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	**0.03 J,B**	--	**0.03 J,B**	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO4)	--	--	--	--	--	--	**0.04 J-,B**	--	--	--	--	--	--	--
Potassium	--	--	--	--	**2.8 J,K,B**	**2.7 J,K,B**	**3.7 J,K,B**	**3.9 J,K,B**	**4.91**	--	--	--	--	--
Sodium	--	--	--	--	**86.5 J,K,B**	**84.9 J,K,B**	**91.2 J,K,B**	--	**103**	--	--	--	--	--
Sulfate (as SO4)	--	250	**291 D**	--	**211**	--	**222**	--	**214**	--	**227**	--	**198**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	<5.0	--	**8.0 J,B**	--	**10.5**	--	--	--	--
Total dissolved solids (Residue, filterable)	--	500	--	**640**	**710 J-**	--	**700 J-**	--	--	**768**	--	**818**	--	**670**
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-7

SUMMARY OF GROUNDWATER RESULTS - HENRY SITE
P4 RI/FS
(Page 15 of 20)

Analyte/Methods (Units)	Location Identification / Location Type / Date Collected		MMW023 Monitoring Well 5/13/2012		MMW023 Monitoring Well 4/25/2013		MMW023 Monitoring Well 5/10/2014		MMW028 Monitoring Well 9/22/2008		MMW028 Monitoring Well 5/14/2009		MMW028 Monitoring Well 5/16/2010	
Metals (mg/l)	**Background mg/l**	**Screening mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	--	0.2	--	--	--	--	--	--	<0.05	<0.05	--	<0.05	--	--
Antimony	--	0.006	--	--	--	--	--	--	--	--	--	<0.00025	--	--
Arsenic	0.00103	0.01	--	--	--	--	--	--	--	--	--	<0.00025	--	--
Barium	--	2	--	--	--	--	--	--	--	--	--	**0.0436**	--	--
Beryllium	--	0.004	--	--	--	--	--	--	--	--	--	<0.0005	--	--
Boron	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.000401	0.005	--	<0.0006 D	--	<0.0003	--	<0.0003	<0.000125	<0.000125	--	<0.000125	--	<0.0003
Chromium, Total	0.00604	0.1	--	--	--	--	--	--	**0.000748 F**	**0.00222**	--	**0.00114 F**	--	--
Cobalt	0.000436	--	--	--	--	--	--	--	--	--	--	<0.00025	--	--
Copper	--	1.3	--	--	--	--	--	--	--	--	--	**0.0231**	--	--
Iron	--	0.3	--	--	--	--	--	--	<0.025	<0.025	<0.025	<0.025	--	--
Lead	0.00146	0.015	--	--	--	--	--	--	--	--	--	<0.00025	--	--
Manganese	0.435	0.05	--	**0.448 D**	--	**0.359 D**	--	**0.371 D**	**0.000871 F**	**0.000704 F**	--	**0.000563 F**	--	--
Mercury	--	0.002	--	--	--	--	--	--	--	--	--	<0.0001	--	--
Molybdenum	0.0239	--	--	--	--	--	--	--	--	--	--	<0.005	--	--
Nickel	--	--	--	--	--	--	--	--	**0.00249 F**	**0.00204 F**	--	**0.00221 F**	--	--
Selenium	0.00278	0.05	--	**0.00256 B**	**0.000765 F**	**0.000956 F**	<0.0005 UJ	<0.0005	**0.00253**	**0.00264**	--	**0.00551**	--	**0.00309**
Silver	--	0.1	--	--	--	--	--	--	--	--	--	<0.00025	--	--
Thallium	0.0002	0.002	--	--	--	--	--	--	--	--	--	<0.00005	--	--
Uranium	--	0.03	--	--	--	--	--	--	--	--	--	**0.00112**	--	--
Vanadium	0.0138	--	--	--	--	--	--	--	<0.005	<0.005	--	<0.005	--	--
Zinc	0.471	5	--	--	--	--	--	--	<0.005	<0.005	--	**1.56**	--	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Carbonate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Hydroxide (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Total (as CaCO3)	--	--	--	--	--	--	--	--	**169**	--	**173**	--	--	--
Calcium	--	--	--	--	--	--	--	--	**54.9**	--	**54.7**	--	--	--
Chloride (as Cl)	--	250	--	--	--	--	--	--	**35**	--	**34.2**	--	--	--
Fluoride	--	4	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	--	--	--	--	--	--	**216**	--	**212**	--	--	--
Magnesium	--	--	--	--	--	--	--	--	**19.2**	--	**18.4**	--	--	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	**0.762**	--	--	--
Phosphorus, total orthophosphate (as PO4)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	--	--	--	--	--	--	--	--	**2.14**	--	**1.89**	--	--	--
Sodium	--	--	--	--	--	--	--	--	**28.5**	--	**26.3**	--	--	--
Sulfate (as SO4)	--	250	**217 J+**	--	**198 D**	--	**201 D**	--	**68**	--	**70.7**	--	**71.2**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	--	--	<2.5	--	<2.5	--	--
Total dissolved solids (Residue, filterable)	--	500	--	**634**	--	**630**	--	**610**	--	**484**	--	**402**	--	**380**
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-7

SUMMARY OF GROUNDWATER RESULTS - HENRY SITE
P4 RI/FS
(Page 16 of 20)

Analyte/Methods (Units)	Location Identification / Location Type / Date Collected		MMW028 Monitoring Well 5/13/2012		MMW028 Dup Monitoring Well 5/13/2012		MMW028 Average Monitoring Well 5/13/2012		MMW028 Monitoring Well 4/25/2013		MMW028 Dup Monitoring Well 4/25/2013		MMW028 Average Monitoring Well 4/25/2013	
Metals (mg/l)	**Background mg/l**	**Screening mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	--	0.2	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	0.006	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.00103	0.01	--	--	--	--	--	--	--	--	--	--	--	--
Barium	--	2	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	0.004	--	--	--	--	--	--	--	--	--	--	--	--
Boron	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.000401	0.005	--	<0.0006 D	--	<0.0006 D	--	<0.0006 D	--	<0.0003	--	<0.0003	--	<0.0003
Chromium, Total	0.00604	0.1	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	0.000436	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	1.3	--	--	--	--	--	--	--	--	--	--	--	--
Iron	--	0.3	--	--	--	--	--	--	--	--	--	--	--	--
Lead	0.00146	0.015	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	0.435	0.05	--	<0.002 D	--	<0.002 D	--	<0.002 D	--	<0.001	--	<0.001	--	<0.001
Mercury	--	0.002	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	0.0239	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	0.00278	0.05	--	**0.00936 D**	--	**0.0115 B**	--	**0.01043 B**	**0.00446**	**0.004**	**0.00409**	**0.00454**	**0.004275**	**0.00427**
Silver	--	0.1	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.0002	0.002	--	--	--	--	--	--	--	--	--	--	--	--
Uranium	--	0.03	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	0.0138	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	0.471	5	--	--	--	--	--	--	--	--	--	--	--	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Carbonate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Hydroxide (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, Total (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloride (as Cl)	--	250	--	--	--	--	--	--	--	--	--	--	--	--
Fluoride	--	4	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Magnesium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total orthophosphate (as PO4)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sulfate (as SO4)	--	250	**72.6 J+**	--	**72.8 J+**	--	**72.7 J+**	--	**65.6**	--	**64.9**	--	**65.25**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total dissolved solids (Residue, filterable)	--	500	--	**294**	--	**312**	--	**303**	--	**310**	--	**310**	--	**310**
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-7

SUMMARY OF GROUNDWATER RESULTS - HENRY SITE
P4 RI/FS
(Page 17 of 20)

Analyte/Methods (Units)	Location Identification / Location Type / Date Collected		MMW028 Monitoring Well 5/10/2014		MMW028 Dup Monitoring Well 5/10/2014		MMW028 Average Monitoring Well 5/10/2014		MPW022 Production Well 5/20/2004		MPW022 Production Well 10/6/2004		MPW022 Production Well 6/24/2005	
Metals (mg/l)	**Background mg/l**	**Screening mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	--	0.2	--	--	--	--	--	--	--	--	--	--	<0.03 K	--
Antimony	--	0.006	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	0.00103	0.01	--	--	--	--	--	--	--	--	--	--	--	--
Barium	--	2	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	0.004	--	--	--	--	--	--	--	--	--	--	--	--
Boron	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	0.000401	0.005	--	<0.0003	--	<0.0003	--	<0.0003	<0.0002 K	--	--	--	<0.0001 K	--
Chromium, Total	0.00604	0.1	--	--	--	--	--	--	<0.0002 K	--	**0.0012 J-,K**	--	**0.001 J,K,B**	--
Cobalt	0.000436	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	1.3	--	--	--	--	--	--	--	--	--	--	--	--
Iron	--	0.3	--	--	--	--	--	--	--	--	--	--	**0.13 J,K,B**	--
Lead	0.00146	0.015	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	0.435	0.05	--	<0.001	--	**0.00143 F**	--	**0.00143 F**	--	--	--	--	**0.0156 J,K,B**	--
Mercury	--	0.002	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	0.0239	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	**0.0007 J,K,B**	--	**0.001 J-,K**	--	**0.0007 J,K,B**	--
Selenium	0.00278	0.05	**0.00298 J**	**0.00321 J**	**0.00313 J**	**0.00337 J**	**0.003055**	**0.00329**	**0.003 J,B**	--	--	--	<0.001	--
Silver	--	0.1	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	0.0002	0.002	--	--	--	--	--	--	--	--	--	--	--	--
Uranium	--	0.03	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	0.0138	--	--	--	--	--	--	--	0.0003 UB,K	--	--	--	<0.0002 K	--
Zinc	0.471	5	--	--	--	--	--	--	<0.004 K	--	**0.101 J-,K**	--	**0.043 J,K,B**	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	--	--	--	--	--	--	**192**	--	**198**	--	**181**
Alkalinity, Carbonate	--	--	--	--	--	--	--	--	--	<2.0	--	<2.0	--	<2.0
Alkalinity, Hydroxide (as CaCO3)	--	--	--	--	--	--	--	--	--	<2.0	--	<2.0	--	<2.0
Alkalinity, Total (as CaCO3)	--	--	--	--	--	--	--	--	--	**192**	--	**198**	--	**181**
Calcium	--	--	--	--	--	--	--	--	**57.1 J,K,B**	--	**52.1 J-,K**	--	**57.2 J,K,B**	--
Chloride (as Cl)	--	250	--	--	--	--	--	--	**4.4**	--	**5.8**	--	**5.4**	--
Fluoride	--	4	--	--	--	--	--	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Magnesium	--	--	--	--	--	--	--	--	**13.2 J,K,B**	--	**12 J-,K**	--	**13.2 J,K,B**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.1**
Phosphorus, total orthophosphate (as PO4)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	--	--	--	--	--	--	--	--	**1.4 J,K,B**	--	**1.1 J-,K**	--	**1.2 J,K,B**	--
Sodium	--	--	--	--	--	--	--	--	**6.8 J,K,B**	--	**6.4 J-,K**	--	**7.4 J,K,B**	--
Sulfate (as SO4)	--	250	**70.4**	--	**69.5**	--	**69.95**	--	**2.9 J,B**	--	**3.1 J**	--	**2.8 J,B**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total dissolved solids (Residue, filterable)	--	500	--	**310**	--	**328**	--	**319**	--	--	--	--	--	--
Total organic carbon	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE B-7

SUMMARY OF GROUNDWATER RESULTS - HENRY SITE
P4 RI/FS
(Page 18 of 20)

Analyte/Methods (Units)		Location Identification Location Type Date Collected	MPW022 Production Well 10/31/2005		MPW022 Production Well 5/14/2006		MPW022 Production Well 9/19/2007		MPW022 Production Well 5/15/2008		MPW022 Production Well 9/24/2008		MPW023 Production Well 10/5/2004	
Metals (mg/l)	**Background mg/l**	**Screening mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	--	0.2	<0.03 K	--	<0.03 K	--	<0.03 K	**0.04 J-,B,K**	<0.03 K	<0.03 K	<0.05	<0.05	--	--
Antimony	--	0.006	--	--	<0.0004 K	--	<0.0004 K	<0.0004 K	--	--	--	--	--	--
Arsenic	0.00103	0.01	--	--	<0.0005 K	--	<0.0005 K	<0.0005 K	--	--	--	--	--	--
Barium	--	2	--	--	**0.027 J,K,B**	--	**0.005 J,K,B**	0.006 UB,K	--	--	--	--	--	--
Beryllium	--	0.004	--	--	<0.002 K	--	<0.002 K	<0.002 K	--	--	--	--	--	--
Boron	--	--	--	--	--	--	<0.01 K	<0.01 K	--	--	--	--	--	--
Cadmium	0.000401	0.005	<0.0001 K	<0.1 K	<0.0001 K	<0.0001 K	<0.0001 K	<0.0001 K	<0.0001 K	<0.0001 K	<0.000125	<0.000125	<0.0001 K	--
Chromium, Total	0.00604	0.1	0.0001 UB,K	<0.1 K	**0.0002 J,K,B**	**0.0004 J,K,B**	<0.0001 K	<0.0001 K	--	--	**0.00127 F**	**0.0013 F**	<0.0001 K	--
Cobalt	0.000436	--	--	--	<0.01 K	--	<0.01 K	<0.01 K	--	--	--	--	--	--
Copper	--	1.3	--	--	<0.01 K	--	<0.01 K	<0.01 K	--	--	--	--	--	--
Iron	--	0.3	**4.3 J,K,B**	**8.06 J,K,B**	**2.39 J,K,B**	--	**0.04 J,K,B**	**1.36 J,K,B**	**0.1 J,K,B**	**0.55 J,K,B**	**0.0368 F**	**0.497**	--	--
Lead	0.00146	0.015	--	--	**0.0001 J,K,B**	--	<0.0001 K	<0.0001 K	--	--	--	--	--	--
Manganese	0.435	0.05	**0.233 J,K,B**	<0.5 K	**0.0926 J,K,B**	--	**0.0279 J,K,B**	**0.0412 J,K,B**	**0.0273 J,K,B**	**0.0276 J,K,B**	**0.0379**	**0.0345**	--	--
Mercury	--	0.002	--	--	<0.0002	--	<0.0002	<0.0002	--	--	--	--	--	--
Molybdenum	0.0239	--	--	--	<0.01 K	--	<0.01 K	<0.01 K	--	--	--	--	--	--
Nickel	--	--	<0.0006 K	<0.6 K	<0.0006 K	**0.0009 J,K,B**	<0.0006 K	**0.0008 J,K,B**	<0.0006 K	<0.0006 K	**0.00106 F**	<0.001	**0.0158 J,K,B**	--
Selenium	0.00278	0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0005	<0.0005	<0.001	--
Silver	--	0.1	--	--	<0.01 UJ,K	--	<0.01 UJ,K	<0.01 K	--	--	--	--	--	--
Thallium	0.0002	0.002	--	--	**0.0002 J,K,B**	--	0.0001 UB,K	<0.0001 K	--	--	--	--	--	--
Uranium	--	0.03	--	--	<0.0001 K	--	<0.0001 K	<0.0001 K	--	--	--	--	--	--
Vanadium	0.0138	--	<0.0002 K	<0.2 K	<0.0002 K	<0.0002 K	<0.0002 K	<0.0002 K	<0.0002 K	<0.0002 K	<0.005	<0.005	<0.00005 K	--
Zinc	0.471	5	**0.127 J,K,B**	**0.547 J,K,B**	**0.006 J,K,B**	**0.155 J,K,B**	<0.002 K	**0.015 J,K,B**	<0.002 K	**0.003 J,K,B**	**0.014 F**	**0.00924 F**	**0.741 J,K,B**	--
Chemistry Parameters (mg/l)														
Alkalinity, Bicarbonate	--	--	--	**179**	--	**125**	--	**75**	--	**63**	--	--	--	**190**
Alkalinity, Carbonate	--	--	--	<2.0	--	<2.0	--	**4.0 J,B**	--	**7.0 J,B**	--	--	--	<2.0
Alkalinity, Hydroxide (as CaCO3)	--	--	--	<2.0	--	<2.0	--	<2.0	--	<2.0	--	--	--	<2.0
Alkalinity, Total (as CaCO3)	--	--	--	**179**	--	**125**	--	**78**	--	**70**	**62.7 J-**	--	--	**190**
Calcium	--	--	**50.2 J,K,B**	--	**23.1 J,K,B**	--	**7.9 J,K,B**	**8.1 J,K,B**	**7.4 J,K,B**	**7.5 J,K,B**	**6.07**	--	**62.6 J,K,B**	--
Chloride (as Cl)	--	250	**5.0**	--	**5.1**	--	**5.1**	--	**5.3**	--	**5.23**	--	**6.6**	--
Fluoride	--	4	--	--	--	--	<0.1	--	--	--	--	--	--	--
Hardness (as CaCO3)	--	--	--	--	**112**	--	**68**	--	**66**	**68**	**59.1**	--	--	--
Magnesium	--	--	**13.2 J,K,B**	--	**13.3 J,K,B**	--	**11.7 J,K,B**	**12 J,K,B**	**11.6 J,K,B**	**11.9 J,K,B**	**10.7**	--	**23.5 J,K,B**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	<0.1	--	<0.1	--	0.5 UB	--	--	--	--
Nitrogen, nitrate-nitrite	--	--	--	<0.02	--	<0.02	--	<0.02	--	<0.02	--	--	--	--
Phosphorus, total orthophosphate (as PO4)	--	--	**0.02 J,B**	--	<0.01	--	**0.01 J-,B**	--	**0.01 J-,B**	--	--	--	--	--
Potassium	--	--	**1.3 J,K,B**	--	**1.2 J,K,B**	--	**1.1 J,K,B**	**0.9 J,K,B**	**1.3 J,K,B**	**1.0 J,K,B**	**1.31**	--	**0.8 J,K,B**	--
Sodium	--	--	**7.0 J,K,B**	--	**7.1 J,K,B**	--	**6.8 J,K,B**	**6.7 J,K,B**	**6.6 J,K,B**	--	**7.38**	--	**9.3 J-,K**	--
Sulfate (as SO4)	--	250	<0.5	--	<0.5	--	<0.5	--	**1.7 J-,B**	--	<0.5	--	**70**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	<5.0	--	<5.0 UJ	--	<5.0	--	<2.5	--	--
Total dissolved solids (Residue, filterable)	--	500	--	--	**120**	--	**60 J-,B**	--	**70 J-**	--	--	**30**	--	--
Total organic carbon	--	--	--	**1.0 J,B**	--	**4.0 J,B**	--	--	--	--	--	--	--	--

TABLE B-7

SUMMARY OF GROUNDWATER RESULTS - HENRY SITE
P4 RI/FS
(Page 19 of 20)

Analyte/Methods (Units)		Location Identification Location Type Date Collected	MPW023 Production Well 6/22/2005		MPW023 Production Well 10/14/2007		MPW023 Production Well 5/18/2008		MPW023 Production Well 9/23/2008	
Metals (mg/l)	**Background mg/l**	**Screening mg/l**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminum	--	0.2	<0.03 K	--	<0.03 K	<0.03 K	<0.03 K	<0.03 K	<0.05	<0.05
Antimony	--	0.006	--	--	<0.0004 K	**0.0004 J,K,B**	--	--	--	--
Arsenic	0.00103	0.01	--	--	**0.0037 J,K,B**	**0.0037 J,K,B**	--	--	--	--
Barium	--	2	--	--	**0.092 J,K,B**	**0.092 J,K,B**	--	--	--	--
Beryllium	--	0.004	--	--	<0.002 K	<0.002 K	--	--	--	--
Boron	--	--	--	--	<0.01 K	**0.02 J,K,B**	--	--	--	--
Cadmium	0.000401	0.005	<0.0001 K	--	<0.0001 K	<0.0001 K	<0.0001 K	<0.0001 K	<0.000125	<0.000125
Chromium, Total	0.00604	0.1	0.0001 UB,K	--	<0.0005 K	0.0004 UB,K	--	--	**0.00283**	**0.00167 F**
Cobalt	0.000436	--	--	--	<0.01 K	<0.01 K	--	--	--	--
Copper	--	1.3	--	--	<0.01 K	<0.01 K	--	--	--	--
Iron	--	0.3	**0.2 J,K,B**	--	**0.24 J,K,B**	**0.28 J,K,B**	**0.2 J,K,B**	**0.26 J,K,B**	**0.23**	**0.303**
Lead	0.00146	0.015	--	--	**0.0003 J,K,B**	**0.0009 J,K,B**	--	--	--	--
Manganese	0.435	0.05	**0.186 J,K,B**	--	**0.211 J,K,B**	**0.2 J,K,B**	**0.2 J,K,B**	**0.197 J,K,B**	**0.212**	**0.204**
Mercury	--	0.002	--	--	<0.0002	<0.0002	--	--	--	--
Molybdenum	0.0239	--	--	--	**0.02 J,K,B**	**0.03 J,K,B**	--	--	--	--
Nickel	--	--	**0.0146 J,K,B**	--	**0.0177 J,K,B**	**0.0176 J,K,B**	**0.0163 J,K,B**	**0.0151 J,K,B**	**0.0179**	**0.0171**
Selenium	0.00278	0.05	<0.001	--	<0.001	<0.001	<0.001	<0.001	**0.000718 F**	**0.000653 F**
Silver	--	0.1	--	--	<0.01 UJ,K	<0.01 K	--	--	--	--
Thallium	0.0002	0.002	--	--	<0.0001 K	**0.0005 J,K,B**	--	--	--	--
Uranium	--	0.03	--	--	**0.0122 J,K,B**	**0.0121 J,K,B**	--	--	--	--
Vanadium	0.0138	--	<0.0002 K	--	**0.001 J,K,B**	<0.0002 K	**0.0002 J,K,B**	<0.0002 K	<0.005	<0.005
Zinc	0.471	5	**0.59 J,K,B**	--	**0.72 J,K,B**	**0.859 J,K,B**	**0.648 J,K,B**	**0.658 J,K,B**	**0.734**	**0.857**
Chemistry Parameters (mg/l)										
Alkalinity, Bicarbonate	--	--	--	**179**	--	**195**	--	**184**	--	--
Alkalinity, Carbonate	--	--	--	<2.0	--	<2.0	--	<2.0	--	--
Alkalinity, Hydroxide (as CaCO3)	--	--	--	<2.0	--	<2.0	--	<2.0	--	--
Alkalinity, Total (as CaCO3)	--	--	--	**179**	--	**195**	--	**184**	**193 J-**	--
Calcium	--	--	**61.1 J,K,B**	--	**64.3 J,K,B**	**63.5 J,K,B**	**60.6 J,K,B**	**57.9 J,K,B**	**56.8**	--
Chloride (as Cl)	--	250	**6.8**	--	**7.0**	--	**7.1**	--	**6.96**	--
Fluoride	--	4	--	--	**0.1 J,B**	--	--	--	--	--
Hardness (as CaCO3)	--	--	--	--	**259**	--	**247**	**239**	**231**	--
Magnesium	--	--	**22.7 J,K,B**	--	**24 J,K,B**	**23.9 J,K,B**	**23.2 J,K,B**	**22.9 J,K,B**	**21.7**	--
Nitrogen, Kjeldahl, Total	--	--	--	--	--	<0.1	--	**0.3 J-,B**	--	--
Nitrogen, nitrate-nitrite	--	--	--	<0.02	--	**0.02 J,B**	--	<0.02	--	--
Phosphorus, total orthophosphate (as PO4)	--	--	--	--	--	--	**0.03 J-,B**	--	--	--
Potassium	--	--	**0.8 J,K,B**	--	**0.8 J,K,B**	**1.1 J,K,B**	**0.9 J,K,B**	**0.9 J,K,B**	**1.01**	--
Sodium	--	--	**9.5 J,K,B**	--	**9.1 J,K,B**	**9.3 J,K,B**	**8.8 J,K,B**	--	**9.74**	--
Sulfate (as SO4)	--	250	**63.1**	--	**68.2**	--	**64.7**	--	**58.5**	--
Suspended solids (Residue, non-filterable)	--	--	--	--	--	--	--	<5.0	--	<2.5
Total dissolved solids (Residue, filterable)	--	500	--	--	**310 J-,B**	--	**310 J-**	--	--	**304**
Total organic carbon	--	--	--	--	--	--	--	--	--	--

TABLE B-7

SUMMARY OF GROUNDWATER RESULTS - HENRY SITE
P4 RI/FS

Footnotes:

mg/l	milligrams per liter.
Bold	Bolded result indicates positively identified compound.
--	Not scheduled.
	Blue shaded result indicates both screening limit and background limit exceeded.
	Yellow shaded result indicates non-detected result is greater than both screening limit and background limit.
B	Analyte detected in an associated blank.
D	Sample dilution required for analysis; reported values reflect the dilution.
F	Analyte was positively identified but the reported concentration is estimated; reported concentration is less than the reporting limit, but greater than the method detection limit.
J	Data are estimated due to associated quality control data. Bias unknown.
J+	Data are estimated due to associated quality control data. Potential high bias.
J-	Data are estimated due to associated quality control data. Potential low bias.
K	Serial dilutions not performed for samples analyzed by this method. (Epa 200.7,200.8)
U	Analyte considered not detected based on associated blank data.
UB	Analyte considered not detected based on associated blank data.
UJ	Potential low bias, possible false negative.

APPENDIX C

PHOTOGRAPHIC LOG OF SURFACE WATER SAMPLING LOCATIONS

MWH

Photographic Log

Client:	Monsanto	Project:	Water Sampling
Site Name:	Henry Mine	Site Location:	Lone Pine Creek Drainage

Photograph ID: 1

Photo Location: MST053: Henry Site, Lone Pine Creek Drainage, Lone Pine Creek, Spring Conditions

Direction: Downstream

Survey Date: 6/3/2004

Comments:

Photograph ID: 2

Photo Location: MST053: Henry Site, Lone Pine Creek Drainage, Lone Pine Creek, Fall Conditions

Direction: Downstream

Survey Date: 11/3/2004

Comments:

Client:	Monsanto	Project:	Water Sampling
Site Name:	Henry Mine	Site Location:	Lone Pine Creek Drainage

Photograph ID: 3

Photo Location:
MST054: Henry Site, Lone Pine Creek Drainage, Lone Pine Creek, Spring Conditions

Direction:
Upstream

Survey Date:
5/23/2008

Comments:

Photograph ID: 4

Photo Location:
MST054: Henry Site, Lone Pine Creek Drainage, Lone Pine Creek, Fall Conditions

Direction:
Upstream

Survey Date:
9/9/2007

Comments:

MWH

Photographic Log

Client:	**Monsanto**	**Project:**	**Water Sampling**
Site Name:	**Henry Mine**	**Site Location:**	**Lone Pine Creek Drainage**

Photograph ID: 5

Photo Location: MST055: Henry Site, Lone Pine Creek Drainage, Lone Pine Creek, Spring Conditions

Direction: Downstream

Survey Date: 4/19/2004

Comments:

Photograph ID: 6

Photo Location: MST056: Henry Site, Lone Pine Creek Drainage, Lone Pine Creek, Spring Conditions

Direction: Upstream

Survey Date: 4/6/2007

Comments:

Client:	Monsanto	Project:	Water Sampling
Site Name:	Henry Mine	Site Location:	Lone Pine Creek Drainage

Photograph ID: 7

Photo Location:
MST057: Henry Site, Lone Pine Creek Drainage, West Fork Above Lone Pine Creek, Spring Conditions

Direction:
Downstream

Survey Date:
3/10/2007

Comments:

Photograph ID: 8

Photo Location:
MST057: Henry Site, Lone Pine Creek Drainage, West Fork Above Lone Pine Creek, Fall Conditions

Direction:
Upstream

Survey Date:
9/9/2007

Comments:

Client:	Monsanto	Project:	Water Sampling
Site Name:	Henry Mine	Site Location:	Lone Pine Creek Drainage

Photograph ID: 9	
Photo Location: MST058: Henry Site, Lone Pine Creek Drainage, Lone Pine Creek, Spring Conditions	
Direction: Downstream	
Survey Date: 5/21/2003	
Comments:	
Photograph ID: 10	
Photo Location: MST058: Henry Site, Lone Pine Creek Drainage, Lone Pine Creek, Unknown Season Conditions	
Direction: Upstream	
Survey Date:	
Comments: Photo included is of unknown date and season condition.	

Client:	Monsanto	Project:	Water Sampling
Site Name:	Henry Mine	Site Location:	Lone Pine Creek Drainage

Photograph ID: 11

Photo Location:
MST062: Henry Site, Lone Pine Creek Drainage, Strip Mine Creek Below Mine, Spring Conditions

Direction:
Upstream

Survey Date:
6/22/2004

Comments:

Photograph ID: 12

Photo Location:
MST063: Henry Site, Lone Pine Creek Drainage, Strip Mine Creek Below Mine, Spring Conditions

Direction:
Upstream

Survey Date:
5/3/2007

Comments:

Client:	Monsanto	Project:	Water Sampling
Site Name:	Henry Mine	Site Location:	Lone Pine Creek Drainage

Photograph ID: 13

Photo Location:
MST064: Henry Site, Lone Pine Creek Drainage, West Fork Above Lone Pine Creek, Spring Conditions

Direction:
Upstream

Survey Date:
5/21/2003

Comments:

Photograph ID: 14

Photo Location:
MST064: Henry Site, Lone Pine Creek Drainage, West Fork Above Lone Pine Creek, Unknown Season Conditions

Direction:
Upstream

Survey Date:

Comments:
Photo included is of unknown date and season condition.

MWH Photographic Log

Client:	**Monsanto**	**Project:**	**Water Sampling**
Site Name:	**Henry Mine**	**Site Location:**	**Lone Pine Creek Drainage**

Photograph ID: 15

Photo Location:
MST226: Henry Site, Lone Pine Creek Drainage, Tributary to Lone Pine Creek, Spring Conditions

Direction:
Downstream

Survey Date:
5/10/2012

Comments:

Photograph ID: 16

Photo Location:
MST275: Henry Site, Lone Pine Creek Drainage, Tributary to Lone Pine Creek, Spring Conditions

Direction:
Downstream

Survey Date:
4/18/2004

Comments:

Client:	**Monsanto**	**Project:**	**Water Sampling**
Site Name:	**Henry Mine**	**Site Location:**	**Lone Pine Creek Drainage**

Photograph ID: 17

Photo Location: MST275: Henry Site, Lone Pine Creek Drainage, Tributary to Lone Pine Creek, Fall Conditions

Direction: Downstream

Survey Date: 11/1/2010

Comments:

Photograph ID: 18

Photo Location: MST276: Henry Site, Lone Pine Creek Drainage, Tributary to West Fork Lone Pine Creek, Spring Conditions

Direction: Downstream

Survey Date: 3/10/2007

Comments:

MWH

Photographic Log

Client:	**Monsanto**	**Project:**	**Water Sampling**
Site Name:	**Henry Mine**	**Site Location:**	**Lone Pine Creek Drainage**

Photograph ID: 19

Photo Location:
MST276: Henry Site, Lone Pine Creek Drainage, Tributary to West Fork Lone Pine Creek, Fall Conditions

Direction:
Upstream

Survey Date:
9/11/2007

Comments:

Photograph ID: 20

Photo Location:
MST280: Henry Site, Lone Pine Creek Drainage, Creek Across MWD088, Fall Conditions

Direction:
Unknown

Survey Date:
9/16/2008

Comments:
Photo shows location in Fall conditions.

MWH

Photographic Log

Client:	**Monsanto**	**Project:**	**Water Sampling**
Site Name:	**Henry Mine**	**Site Location:**	**Long Valley Creek Drainage**

Photograph ID: 1

Photo Location:
MST051: Henry Site, Long Valley Creek Drainage, East Fork Long Valley Below Mine

Direction:
Upstream

Survey Date:
3/10/2007

Comments:

Photograph ID: 2

Photo Location:
MST271: Henry Site, Long Valley Creek Drainage, East Fork Long Valley Below Mine

Direction:
Downstream

Survey Date:
4/17/2004

Comments:
Still Dry

Client:	**Monsanto**	**Project:**	**Water Sampling**
Site Name:	**Henry Mine**	**Site Location:**	**Mine Area**

Photograph ID: 1

Photo Location:
MSG002: Henry Site, Mine Area, Taylor Spring, Spring Conditions

Direction:
Upstream

Survey Date:
5/3/2007

Comments:

Photograph ID: 2

Photo Location:
MSG002: Henry Site, Mine Area, Taylor Spring, Fall Conditions

Direction:
Downstream

Survey Date:
8/4/2007

Comments:

Client:	**Monsanto**	**Project:**	**Water Sampling**
Site Name:	**Henry Mine**	**Site Location:**	**Mine Area**

Photograph ID: 3

Photo Location:
MDS016: Henry Site, Mine Area, South Pit Dump Seep, Spring Conditions

Direction:
Upstream

Survey Date:
4/21/2004

Comments:

Photograph ID: 4

Photo Location:
MDS022: Henry Site, Mine Area, South Pit Dump Limestone Drain, Spring Conditions

Direction:
Upstream

Survey Date:
5/13/2006

Comments:

Client:	Monsanto	Project:	Water Sampling
Site Name:	Henry Mine	Site Location:	Mine Area

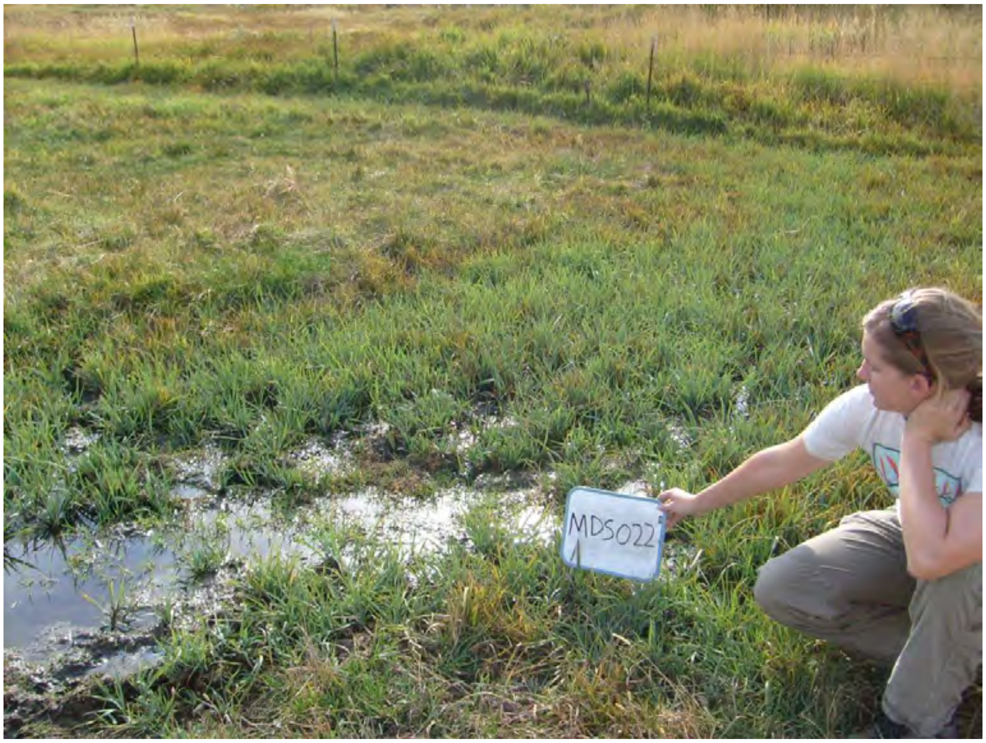
Photograph ID: 5

Photo Location:
MDS022: Henry Site, Mine Area, South Pit Dump Limestone Drain, Fall Conditions

Direction:
Downstream

Survey Date:
8/4/2007

Comments:



Photograph ID: 6

Photo Location:
MDS034: Henry Site, Mine Area, Dump Seep #3, Spring Conditions

Direction:
Downsteram

Survey Date:
5/31/2009

Comments:

MWH

Photographic Log

Client:	Monsanto	Project:	Water Sampling
Site Name:	**Henry Mine**	**Site Location:**	**Mine Area**

Photograph ID: 7

Photo Location:
MSP014: Henry Site, Mine Area, Pond on Waste Rock Dump MWD085, Spring Conditions

Direction:
Downstream

Survey Date:
4/14/2004

Comments:

Photograph ID: 8

Photo Location:
MSP014: Henry Site, Mine Area, Pond on Waste Rock Dump MWD085, Fall Conditions

Direction:
Upstream

Survey Date:
8/4/2007

Comments:

Client:	Monsanto	Project:	Water Sampling
Site Name:	**Henry Mine**	**Site Location:**	**Mine Area**

Photograph ID: 9

Photo Location:
MSP015: Henry Site, Mine Area, Pond on Waste Rock Dump MWD086, Spring Conditions

Direction:
Downstream

Survey Date:
4/18/2004

Comments:

Photograph ID: 10

Photo Location:
MSP015: Henry Site, Mine Area, Pond on Waste Rock Dump MWD086, Fall Conditions

Direction:
Downstream

Survey Date:
10/31/2010

Comments:

Client:	**Monsanto**	**Project:**	**Water Sampling**
Site Name:	**Henry Mine**	**Site Location:**	**Mine Area**

Photograph ID: 11

Photo Location:
MSP016: Henry Site, Mine Area, Pond on Waste Rock Dump MWD085, Spring Conditions

Direction:
Upstream

Survey Date:
5/4/2006

Comments:

Photograph ID: 12

Photo Location:
MSP016: Henry Site, Mine Area, Pond on Waste Rock Dump MWD085, Fall Conditions

Direction:
Upstream

Survey Date:
10/31/2010

Comments:

MWH

Photographic Log

Client:	**Monsanto**	**Project:**	**Water Sampling**
Site Name:	**Henry Mine**	**Site Location:**	**Mine Area**

Photograph ID: 13	
Photo Location: MSP055: Henry Site, Mine Area, South Pit Pond, Spring Conditions	
Direction: Downstream	
Survey Date: 4/14/2004	
Comments:	

Stantec

Photographic Log

Client:	**Monsanto**	**Project:**	**Water Sampling**
Site Name:	**Henry Mine**	**Site Location:**	**Little Blackfoot River**

Photograph ID: 1

Photo Location:
MST234: Henry Site, Little Blackfoot River, River Immediately Above Blackfoot Reservoir, Spring Conditions

Direction:
Downstream

Survey Date:
4/20/2004

Comments:

Photograph ID: 2

Photo Location:
MST234: Henry Site, Little Blackfoot River, River Immediately Above Blackfoot Reservoir, Fall Conditions

Direction:
Downstream

Survey Date:
9/9/2007

Comments:

Client:	**Monsanto**	**Project:**	**Water Sampling**
Site Name:	**Henry Mine**	**Site Location:**	**Little Blackfoot River**

Photograph ID: 3

Photo Location:
MST043: Henry Site, Little Blackfoot River, River Below Long Valley and Mine, Fall Conditions

Direction:
Downstream

Survey Date:
9/11/2004

Comments:
Photo shows site during fall conditions.

Photograph ID: 4

Photo Location:
MST044: Henry Site, Little Blackfoot River, River Immediately Below the Mine, Spring Conditions

Direction:
Downstream

Survey Date:
3/9/2007

Comments:

Client:	Monsanto	Project:	Water Sampling
Site Name:	Henry Mine	Site Location:	Little Blackfoot River

Photograph ID: 5

Photo Location: MST044: Henry Site, Little Blackfoot River, River Immediately Below the Mine, Fall Conditions

Direction: Downstream

Survey Date: 9/14/2004

Comments:

Photograph ID: 6

Photo Location: MST045: Henry Site, Little Blackfoot River, River Above Henry Creek and Mine, Spring Conditions

Direction: Upstream

Survey Date: 3/9/2007

Comments:

Client:	**Monsanto**	**Project:**	**Water Sampling**
Site Name:	**Henry Mine**	**Site Location:**	**Little Blackfoot River**

Photograph ID: 7

Photo Location:
MST045: Henry Site, Little Blackfoot River, River Above Henry Creek and Mine, Fall Conditions

Direction:
Upstream

Survey Date:
9/21/2009

Comments:

Photograph ID: 8

Photo Location:
MST046: Henry Site, Little Blackfoot River, River Below Enoch Valley Creek, Spring Conditions

Direction:
Downstream

Survey Date:
6/3/2004

Comments:

Stantec

Photographic Log

Client:	**Monsanto**	**Project:**	**Water Sampling**
Site Name:	**Henry Mine**	**Site Location:**	**Little Blackfoot River**

Photograph ID: 9

Photo Location:
MST047: Henry Site, Little Blackfoot River, River Above Enoch Valley Creek, Spring Conditions

Direction:
Upstream

Survey Date:
6/3/2004

Comments:

APPENDIX D

COMMENTS AND COMMENT RESPONSE DOCUMENTS

APPENDIX D-1

A/T Comments on *P4's Henry Mine Remedial Investigation Report, Draft Rev 0, August 2016*

Transmitted to P4 on December 19, 2016

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
IDAHO OPERATIONS OFFICE
950 West Bannock, Suite 900
Boise, Idaho 83702

December 19, 2016

Molly R. Prickett
Environmental Engineer
Monsanto Company
Soda Springs Operations
1853 Highway 34
Soda Springs, Idaho 83276

Re: A/T Comments on Draft Henry Mine Site RI Report

Dear Ms. Prickett,

The Agencies and Tribes (A/T) have reviewed the above referenced deliverable, submitted pursuant to the Administrative Settlement Agreement and Order on Consent/Consent Order for Performance of Remedial Investigation and Feasibility Study at the Enoch, Henry, and Ballard Mine Sites in Southeastern Idaho (or 2009 AOC). This letter transmits comments.

Please review the comments and provide responses. We will be available to discuss these comments in the coming weeks. Please contact me if you have questions. I can be reached at 208-378-5763 or electronically at tomten.dave@epa.gov.

Sincerely,

//s//

Dave Tomten
Remedial Project Manager

Enclosure

cc: Mike Rowe, IDEQ - Pocatello
Sandi Fisher, US FWS - Chubbuck
Kelly Wright, Shoshone Bannock Tribes
Susan Hanson (for the tribes)
Sherri Stumbo, Forest Service – Pocatello (electronic version only)
Colleen O'Hara, BLM – Pocatello
Vance Drain, MWH (electronic version only)
Cary Faulk, Integrated-Geosolutions (electronic version only)

Shannon Ansley, Shoshone Bannock Tribes (electronic version only)
Dennis Smith, CH2MHill (electronic version only)
Gary Billman, IDL – Pocatello (electronic version only)
Jeremy Moore, US FWS – Chubbuck (electronic version only)

Comments on Henry Mine RI

General Comments

A. Several portions of this report refer the reader back to the Blackfoot Bridge Environmental Impact Statement (EIS). Although referencing the report is valid, this report should be a stand-alone document, not one that relies on an EIS from another mine site. Please revise the Remedial Investigation (RI) report and for those discussions that refer to the EIS, add the appropriate discussions so that it is unnecessary for the reader to read the EIS or the Ballard RI report.

B. Overall, contaminants of concern (COC) in groundwater appear to be largely below maximum contaminant levels (MCL) and not migrating offsite. The COC concentrations also appear to be relatively stable, but respond to large snowmelt events (in particular, the above-average snowpack of 2011). However, data gaps in monitoring groundwater are identified in appropriate sections and on the drawings. The report contains numerous speculative statements such as "it is possible" or "probably flows" or "likely" or "either to the northwest or southeast." Statements such as these suggest to reviewers that questions, uncertainties, and data gaps still exist in the site characterization and undermine the conceptual site model (CSM). Revise statements to be more conclusive, or provide additional data or interpretation to eliminate the need for speculation. In addition, several specific comments note potential data gaps with respect to groundwater characterization, and raise questions about the adequacy of the well networks for determining groundwater flow direction and fate of contaminants. In addressing these comments, please identify uncertainties, discuss amount and type of information necessary to support remedial decision making, and identify potential data gaps that must be addressed at the RI stage of the process.

C. In general, Appendix A of the report is well prepared and is likely to support future remedial decisions. However, it would benefit from revisions to reference the most current U.S. Environmental Protection Agency (EPA) data sources and software. Although risk assessments generally default to protective assumptions to address unknown uncertainties, the toxicity values for arsenic and uranium are notable exceptions. For arsenic, the current cancer slope factor underestimates the risk of internal cancers, but a replacement value is not currently available. For uranium, the recent oral Minimal Risk Level (MRL) prepared by ATSDR is recommended as a superior alternative to the outdated IRIS Reference Dose (RfD) (see attached).

D. The EPA has recently released the 2016 Aquatic Life Ambient Water Quality Criterion for Selenium in Freshwater. This document provides chronic values for lotic, lentic waterbodies, and selenium in fish tissue whole body and egg/ovary, and reflects the best available science. Although these changes have not been adopted by the State of Idaho, they are Relevant and Appropriate Requirement [ARAR]). Please revise appropriate tables. In addition, EPA recently disapproved the State of Idaho's water quality criterion for Arsenic for the protection of human health. The relevant and appropriate requirement should be revised from 10 to 6.2 ug/l.

E. Volatile organic compounds (VOCs) are not in the list of COPCs for the Henry Mine Site and the human health conceptual site model (Figure 6-1) does not include inhalation as a route of exposure for groundwater. Thus, delete the VOC inhalation concentration column from tables in attachments B, C, D and E of Appendix A, or provide a rationale for using VOC inhalation concentration for groundwater exposure of future residents and future seasonal ranchers in the text and table notes.

F. Conclusions of Appendix A, as written, provide a good summary of the Baseline Risk Assessment (BRA). This section would benefit from emphasizing the objectives of the BRA, along with providing concluding statements regarding unacceptable risks associated with specific areas of Henry Mine Site, and major risk drivers for the Human Health Risk Assessment (HHRA), Ecological Risk Assessment (ERA), and Livestock Risk Assessment.

G. Tables in Appendix A have some inconsistencies in the calculations of hazard quotients (HQ) and ecological hazard values. These calculations won't affect the final conclusions of the BRA; however, it would be good to revise all the calculations in the tables for accuracy and consistency in rounding decimals.

Specific Comments

Report

1. Section ES.4.1; Page ES-4; Paragraph 1 (partial); Sentence 3 (last)

Reword this sentence beginning "Depending on how the site …" as it reads awkwardly.

2. Section ES.4.1; Page ES-4; Paragraph 2; Sentence 4

Change to "Upland soil collected primarily from the soils developed on the graded and reclaimed waste rock dumps comprises …"

3. Section 1.2.2; Page 1-5; Henry Mining and Reclamation History, second paragraph, 5th sentence

Please clarify, does "As a result, most of the mine pits have been backfilled, graded to promote storm water drainage away from the pit backfill, and were covered and seeded to prevent erosion," mean that the storm water is draining into the pit or away from the pit? What does "away from" mean?

4. Section 2.5.2; Page 2-10; Vegetation, second bullet

This section describes milk-vetch as a Group 1-primary selenium accumulator species without discussing what Group 1 means, or directing the reader to a table with this information. Please revise for clarification.

5. Section 2.5.2, Page 2-10, last bullet

Reference where the list was obtained for which plant species were considered as culturally significant plants during the vegetation sampling/survey.

6. Section 2.6.1; Page 2-11; Regional Hydrogeology

Text states, "The alluvial groundwater typically is *unconfined* by lower permeability layers." Lower permeability layers typically confine groundwater? Check wording and revise if necessary.

7. Section 2.6.2.2; Page 2-19; Piezometric and Temperature monitoring

Text states "it is possible there is increased loss from the river to the Wells Formation during high flow events, and this is an area of significant recharge…." This is a potential data gap. To confirm or refute this assertion, streamflow measurements up and down from where the Little Blackfoot River (LBFR) crosses the Wells Formation could be conducted. If the LBFR creates significant recharge to the Wells Formation, and the river becomes impacted by COCs, then this is an important component of the CSM that must be addressed.

8. Section 2.6.2. 2; Page 2-19; Piezometric and Temperature monitoring

a. Text states "MWs MMW011 and MMW023 are on the *conceptual* flow line in the Wells Formation that is *assumed* to terminate at the Henry Springs…" [italics added]. Two wells with 10 feet of water level difference do not necessarily define a groundwater flow direction. An apparent gradient to the north does not mean the groundwater flows north; just that there is a possible northward component of overall flow. Data from nearby mine sites indicates that the gradient and flow direction in the Wells Formation is generally more to the west. Defining the flow direction and gradient in the Wells Formation is an important part of the Site Characterization and CSM. See also 2010 technical memorandum on this topic that was re-circulated recently.

b. Was, or is, the Henry Spring being sampled or monitored? Has the discharge from this spring been chemically "typed" and compared with Wells Formation water? Have site COCs been detected? Please provide data. If this spring is downgradient from the site and discharges Wells Formation groundwater, data from this spring are important to the CSM and COC Fate and Transport (F&T).

9. Section 2.7; Page 2-21; Paragraph 2 (last); Line 7-8

Use of the term leeward is usually associated with wind. Use direction (for example, north and east) or indicate the prevailing wind direction at the site. Please clarify.

10. Section 2.9; Page 2-23; Paragraph 5 (last); Sentence 4

Confirm the date on the establishment of the Fort Hall Reservation, as 1863 would be 5 years prior to the signing of the treaty in 1868.

11. Section 2.10.1; Page 2-24; Phosphoria Formation, first paragraph:

The discussion indicates that there are "naturally elevated background concentrations that result in elevated concentrations of some elements downslope of Meade Peak outcrops in soils and also likely in stream sediment, and possibly downgradient in groundwater and surface water." According to the tables provided in the P4 Background Tech Memo FINAL-Rev 0_March 2013, none of the sediment, surface water or groundwater samples exceeded the screening level for selenium, the site driver. The only elevated selenium samples this reader observed in the background data was for approximately eight soil samples. It appears that the statement made is unsupported by the data, and should be re-phrased to specify which elements you are considering in the statement; bring in the data from the background tech memo for the reader to review.

12. Section 2.10.1; Page 2-24; Paragraph 3; Line 4

This sentence implies that all constituents are elevated in soils overlying undisturbed and pre-mined areas of Meade Peak Member. If memory serves, background concentrations at Caldwell Canyon did not differ much from background concentrations observed at other formation/member outcrops (Dinwoody, Wells). Insert a qualifier in this sentence; perhaps, "Please note that for some undisturbed and pre-mined areas …"

13. Section 2.10.1; Page 2-25; Phosphoria Formation

Rather than referring to another report, please provide a summary table that shows elemental concentrations in the Meade Peak Member to assist in comparisons.

If background concentrations are naturally elevated, please cite the document reporting this information, provide a summary of background concentrations, and identify COCs that are truly elevated as a result of activities at the Henry Mine.

14. Section 2.10.2; Page 2-28; Paragraph 1 (partial); Sentence 2 (last)

Explain why data from South Rasmussen Mine (SRM), in particular, will be useful for establishing hydrogeologic characteristics for a location with uncovered center waste shale. The area of study at SRM is a waste rock dump that is covered.

15. Section 3.5; Page 3-4

There is a potential data gap in surface water sampling locations along the Little Blackfoot River, between MST044 to the confluence with Long Valley Creek/Long Valley Creek Tributary.

16. Section 4.1.3; Page 4-5; Paragraph 3; Sentence 3

Change to “However, as seen on Table 4-1, most of concentrations are within about two times the background level.”

17. Section 4.1.4.2; Page 4-7; Paragraph 3; Sentence 4

Delete “with a mean of 4.04pCI/m^2-s,” as it is mentioned in the following sentence.

18. Section 4.2.6; Page 4-14; Paragraph 1

If it was “not possible to segregate riparian vegetation results by plant species,” how were preliminary COC concentrations in culturally significant riparian vegetation measured? Discuss.

19. Section 4.3.4.1; Page 4-20; Paragraph 4; Sentence 4

The sentence says, “While these concentrations [for sediment] are notable, they have little relevance to the Site as they are not associated with the Site nor were they considered background.” Yet, two paragraphs previous for riparian soil, “Because these stations were identified as being associated with the Site and not background locations, they were included in the risk calculations for the Site (see Section 6.0).” Explain this seeming discrepancy.

20. Section 4.4, Page 4-3, Paragraph 1, Sentence 1

This sentence states that “selenium is the most common contaminant detected at the site.” Tables A2-1 through A2-7 show that selenium in not the most common contaminant detected in any medium. The sentence should be revised.

21. Section 4.4, Page 4-3, Paragraph, Sentence 2

This sentence is not accurate as EPA released new federal water quality criteria for selenium in June 2016 that no longer supports the previous 0.005 milligram per Liter (mg/L) chronic criterion. The current federal water quality criteria (WQC) document recommends water-based lentic and lotic values of 1.5 and 3.1 micrograms per Liter (µg/L), respectively, along with tissue-based. Revisions to the text are necessary to acknowledge the updated federal criteria for selenium.

22. Section 4.4.1; Page 4-23; Preliminary Contaminants of Concern…, last paragraph and page 4-24 first paragraph and elsewhere in the document

Delete the word “slightly” where it describes sampling from the sentences where exceedances are spoken about (and elsewhere in the document) as this term is subjective. A constituent either exceeds or does not exceed screening criteria. Modify as necessary to describe the magnitude of exceedance.

23. Section 4.4.2; Page 4-26; Paragraph 2; Sentence 5

Change: “This pond is typically dry in the fall (Figure 4-7),” to “This pond is typically dry in the fall, note the absence of sampling data in the fall on Figure 4-7.”

24. Section 4.4.3; Page 4-27; Paragraph 3 (last); Sentence 3

Delete “slightly” (too subjective, especially when concentrations are two and three times the criterion) and change to “exceed” (for subject-verb agreement) to read “… MDS016 (0.018 mg/L) exceeds the screening criteria, and two of three samples from MSG002 (0.012 and 0.016 mg/L) exceed the screening criteria.”

25. Section 4.4.3; Page 4-28; Paragraph 2; Sentence 1

Only one of six concentrations in Table 4-10 for arsenic were reported at the method detection limit (MDL). Revise.

26. Section 4.4.3; Page 4-28; Paragraph 2; Sentence 2

Based on Table 4-10, it looks like the maximum arsenic concentration should be 0.0079 mg/L in MDS034 in Spring 2008. Revise.

27. Section 4.4.4.1, Page 4-28, last paragraph, Sentence 3

Dilution is one of several processes for which attenuation may occur. Revise the sentence to read "… through attenuation (e.g, dilution)."

28. Section 4.4.4.1; Page 4-30; Bullet 3

Shouldn't the value 0.0011 mg/L be included in the MST276 box on Drawing 4-10 where the three samples shown were all nondetects? Revise accordingly.

29. Section 4.4.4.1; Page 4-31; Paragraph 2; Line 1

According to the MST275 box in Drawing 4-10, the minimum should be less than 0.001 mg/L. Revise accordingly.

30. Section 4.4.4.1; Page 4-31; Paragraph 2; Line 3

According to the MST275 box in Drawing 4-10 the minimum should be 0.0005 mg/L. Revise accordingly.

31. Section 4.4.4.2; Page 4-32; Little Blackfoot River

Figures 4-10 and 4-11 do not show sampling results for 2011. Was sampling performed in 2011? If so, please include this information. If not, please include a comment as to why sampling was not performed.

32. Section 4.4.4.2; Page 4-32; Little Blackfoot River

There appears to be a data gap in surface water sampling locations along the Little Blackfoot River, between MST044 to the confluence with Long Valley Creek/Long Valley Creek Tributary.

33. Section 4.5.2; Page 4-36; Hydrostratigraphy Units

Describe the sampling results of the Monsanto agricultural wells (MAWs) and Monsanto Domestic Wells (MDWs).

34. Section 4.5.2; Page 4-36; Paragraph 6 (last); Sentence 1

Where are total dissolved solids (TDS) concentrations shown on Drawing 4-11? Revise accordingly.

35. Section 4.5.2.1; Page 4-38; Shallow Alluvial Unit

Does the water in the alluvial aquifer flow downward to lower bedrock units? If alluvial groundwater is or becomes impacted and flows into deeper aquifers, the CSM needs to reflect this possibility. Evaluate vertical groundwater gradients.

Text states, "Surface water flow is *presumed* to be directed westward. (1) Should this be "*Groundwater* flow …." (2) Part of site characterization and developing the CSM is to identify the groundwater flow direction; not *presume* where it is directed.

From the western mouth of the canyon, the LBFR flows to its confluence with Long Valley Creek and then northwest toward the Blackfoot Reservoir; the site geology map (Drawing 2-2) indicates a ribbon of alluvium. However, no direct push borings or alluvial wells are located along this corridor (Drawing 3-3; 4-11). This is the direction of surface water flow, downgradient of the mine site, and likely shallow groundwater flow in the alluvium, based on the topography. Does shallow groundwater data exist for this area or does this represent a potential data gap?

36. Section 4.5.2.1; Page 4-40; Shallow Alluvial Unit

Explain the cadmium results in MMW004 and other wells. Describe the less-than-0.1 (non)detect (above MCL, but below detection limit) (see Drawing 4-11).

37. Section 4.5.2.1; Page 4-41; Shallow Alluvial Unit

Text states that alluvium was investigated using "….two monitoring wells." Explain how flow direction is calculated from only two monitoring wells.

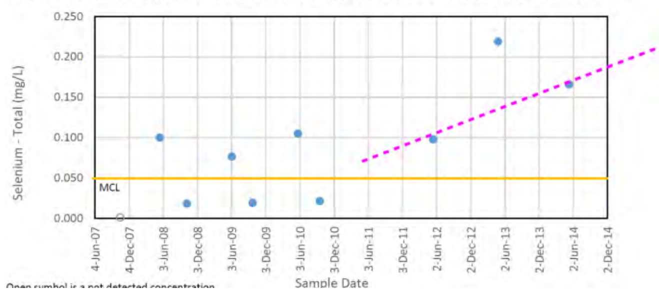
38. Section 4.5.2.1; Page 4-42; Shallow Alluvial Unit; Paragraph 5 (last); Line 6

Text states, "This drainage was investigated with three boreholes (BH072, BH076, and BH079)." Should 076 be 078? Revise accordingly.

39. Section 4.5.2.1; Page 4-43; Shallow Alluvial Unit, Figure 4-15

Text states "Selenium concentrations in MMW010 exceed the criteria of 0.05 every spring…and all fall results are below 0.05 mg/L." According to Figure 4-15, no fall samples are available after 2010, and since 2011 the springtime samples have increased and are as high as 0.219 mg/L. Fall samples could very well be above the MCL by now. Either provide fall samples, or modify statement to say that no fall samples have been collected since 2010, and the 2013 and 2014 samples are historic highs.

FIGURE 4-15
TIME SERIES SELENIUM CONCENTRATIONS FOR MONITORING WELL MMW010



40. Section 4.5.2.2; Page 4-45; Dinwoody Formation

Text states "Constituents from the Site could migrate northeastward perpendicular to the syncline axis toward the Henry Thrust Fault, or parallel to the axis of the syncline toward the northwest." The goal of a site characterization/RI is to determine with confidence which way the water flows and thus evaluate where the COCs may migrate – please provide rationale for this statement, or additional discussion.

Text states that two monitoring wells were installed to evaluate these flow paths – two monitoring wells do not appear to be adequate to enable characterizing the flow direction and gradient in the Dinwoody formation. Please clarify and resolve.

41. Section 4.5.2.2; Page 4-45; Dinwoody Formation

Regarding the elevated selenium concentrations in MMW022 after the "large recharge event of 2011" and that the elevated concentrations are an advancing pulse from an "uncommon" recharge event, as opposed to an advancing plume - following text states that concentrations should decrease in future sampling rounds "*assuming additional anomalous recharge events do not occur.*" It cannot be predicted if, and when, another uncommon or anomalous recharge event will occur. This reasoning appears flawed; please revise.

42. Section 4.5.2.3; Page 4-46; Wells Formation

Text states "flow direction in the Wells Formation at the site is *predicted* to be to the northwest toward the springs…" See previous comment (#35) – the flow direction in the Wells Formation aquifer is important for determination of the fate and transport of COCs. Typically, flow direction in the area is more to west; flow direction should be confirmed by site data. Please clarify and resolve.

43. Section 4.5.2.3; Page 4-48; Paragraph 1; Sentence 2

If all but one selenium concentration was a non-detect, then all but one concentration represented in Figures 4-19 and 4-20 should be open symbols. Revise accordingly.

44. Section 4.5.2.4; Page 4-49; Other Hydrostratigraphic Units

Text describes how the wells are likely downgradient of the mine pit and upgradient of the Lone Pine creek. Provide more data to substantiate this assertion. Show this on the cross section to illustrate the argument.

45. Section 4.5.3; Page 4-51; Water Quality Typing

Text states "were [sic] oxidizing sulfides are a source of selenium." (1) Change "were" to "where" and (2) Are the oxidizing sulfides the actual source of selenium, or do they merely increase the mobility? This statement is not clear – the middle waste shale is typically identified as the source of selenium. Please clarify the statement.

46. Section 4.5.5; Page 4-53; Aquifer Solids

Text states, "*It is possible* that at this location the alluvium was derived largely from the Meade Peak Member outcrop." Please review drilling logs to evaluate whether information is available to address this question of interest. It should be obvious if the alluvium is derived from the Meade Peak formation. For future characterization activities, the onsite geologist should carefully log the borings and evaluate the provenance of the alluvium to accurately characterize the site. During future investigations, please provide detailed logging and observations of drill cuttings and lithologic samples.

47. Section 5.1.4; Page 5-7; Groundwater Pathways

Text states "This resulted in validation of potential pathways and identification of those pathways requiring further investigating." Has further investigation been conducted, and if so, what are the results?

48. Section 5.1.4; Page 5-7; Groundwater Pathways

Text states, "Deeper groundwater flows generally along bedrock bedding is either to the northwest or southeast." This statement is confusing as written and suggests a lack of site knowledge. Revise.

49. Section 5.1.4.2; Page 5-9; Dinwoody Formation

This section describes flowpaths from waste dumps into the Dinwoody and general groundwater flow in the Dinwoody Formation. Text states "Contaminated external waste rock dump seepage entering the Dinwoody Formation…..forms complete flow paths." In nearby sites, elevated COCs in the Dinwoody Formation are observed where waste rock dumps directly overly this unit (for example, elevated COCs are found where MWD086 overlies the Dinwoody and MMW022). Another example where this could occur at the Henry Mine is where MMW085 overlies the Dinwoody Formation (Drawings 2-2 and 5-2 [Section P-P']. No monitoring well is installed to monitor this portion of the Dinwoody Formation (Trd) and is considered a data gap**.** See General Comment B for direction.

50. Section 5.1.4.3, Page 5-9; Wells Formation Groundwater System

As noted, the Wells Formation is considered a host of regional and/or intermediate groundwater systems. The report provides a compelling argument that the Wells Formation groundwater is fault-controlled and that, "these Faults appear affecting and focusing regionals groundwater transport and discharge" and that "This flow direction is supported by site data, specifically the piezometric levels in monitoring wells MMW011 and MMW023."

a. The wells Formation is interrupted by folding and faulting throughout the region. However, regional data indicate that despite the structural controls, the Wells Formation aquifer exhibits a relatively uniform groundwater elevation and gradient, with flow generally to the west. Two monitoring wells located in the northern part of the site do not necessarily provide the required data to evaluate site-wide flow directions and gradients. This is a potential data gap. Please include regional data from other mine sites (e.g. data from 2010 Technical Memorandum – Groundwater Flow in the Wells Formation), or other wells constructed in the Wells Formation to enhance the discussion and support assertions (in addition to the two observed piezometric levels on site). See General Comment B for direction.

b. No monitoring wells have been constructed south of the LBFR so, despite open and backfilled mine pits and large areas of Wells Formation outcrop, the entire southern two-thirds of the site has no groundwater data for Wells Formation. For example, Drawing 5-3 (Cross Section N-N') shows a fairly idealized scenario where a backfilled/open mine pit with a pond (MSP055, which contains elevated cadmium, nickel, selenium, and zinc that exceed surface water and groundwater screening levels) could recharge directly into the Wells Formation and introduce COCs. This is considered a data gap. See previous comment, and also General Comment B for direction.

51. Section 5.1.4.4; Page 5-11; Structural Flow System

The second paragraph describes a potential east-west trending structure located between MMP-041 and MMP043, and the third paragraph describe other smaller faults in the site vicinity. The report concludes that these potential structures would not likely affect groundwater flow. The reviewer would like to acknowledge that he appreciates the extra effort put into the site investigation to look further than existing data points to identify previously unknown structures and evaluate their potential to influence COC fate and transport. Nice job.

52. Section 5.3.3; Page 5-18; Surface Water

The text states that COCs do not make it to LBFR via Lone Pine Creek and that the most downstream affected station is MST057. Suggest adding that MST056 is nondetect and therefore delineates the downstream extent of COCs in Lone Pine Creek.

53. Section 5.3.3, Page 5-18, Paragraph 2, Sentence 3

Dilution is one of several processes through which attenuation may occur. Revise the sentence to read "Through attenuation (e.g, dilution)…"

The second part of this sentence "…concentrations of contaminants…" should be revised to read "…elevated concentrations of contaminants…"

54. Section 5.3.4; Page 5-20; Groundwater

The text states "The southeast portion of waste rock dump MWD085 is adjacent to and overlies the basalt (Drawing 2-2). Therefore seepage or infiltration from MWD085 may recharge and could cause impacts to groundwater within the basalt." Based on Drawings 2-2 and 5-2 (Cross Section P-P'), MWD085 overlies the Dinwoody and upper Meade Peak (Rex Chert/Cherty Shale) formations, but does not directly overlie basalt. Please revisit and revise this discussion to be more accurate. In addition, no data are available to evaluate the potential impacts to the Dinwoody Formation beneath MWD085; and is thus considered a data gap. See General Comment B for direction.

55. Section 5.3.4.1, Page 5-23; Alluvial System

Text states "Groundwater samples collected further downgradient at BH169 (0.016 mg/L)…" Double-check this value; it should be 0.0016 mg/L.

56. Section 5.3.4.2; Page 5-24; Dinwoody Formation

The text describes:

- the interaction between waste rock dumps and the Dinwoody Formation, where the lack of alluvial material allows direct infiltration into the Trd;

- how MMW022 was installed as a “worst case” scenario to evaluate COC loading in the Trd; and
- how MMW022 shows elevated COCs (near the MCL for selenium) that are related to the large recharge of 2011.

This discussion reinforces the need for a monitoring well in the Dinwoody underneath MWD085, which is in direct contact with the Dinwoody (outcrops of Dinwoody are clearly evident adjacent to this waste rock pile). This appears to be an idealized situation to contribute elevated COCs into the Dinwoody and reduce its potential as a beneficial use aquifer. See also Specific Comment 55.

57. Section 5.3.4.3; Page 5-26; Wells Formation

The text attributes low concentrations of COCs in the Wells Formation to a lack of selenium mobility in reducing conditions and reducing flowpaths, among other reasons. However, no monitoring well is constructed in the Wells Formation beneath pond MSP055, which contains some of the highest COC concentrations at the site and sits directly on Wells Formation exposed in the mine’s footwall. Clarify how this determination was made.

58. Section 5.3.4.4; Page 5-26; Migration Summary in Site Groundwater Systems

The text states, with respect to the Dinwoody Formation, that “concentrations in the unit increase with increased winter precipitation and snowmelt. However, to date screening criteria have not been exceeded in this unit.” Note that in MMW022, the average sulfate concentration exceeds the screening level, and selenium is very close to the MCL. It is possible that future large precipitation events could push the selenium level higher. Revisit and revise narrative.

59. Section 6.1, Page 6-3, Paragraph 2, Sentence 3

Remove the two occurrences of “incremental” from the sentence. Using “incremental ILCR” is duplicative since ILCR is an acronym for incremental lifetime cancer risk.

60. Section 6.4, Page 6-6, bullets.

Revised the introductory sentence for the bullets to say, “… are generally interpreted as follows:” Also, the second and third bullets are confusing as written. The second bullet indicates that exposures above the no observed adverse effect level (NOAEL), but below the lowest observed adverse effect level (LOAEL), may pose an unacceptable risk to individuals; the third bullet indicates exposures above the LOAEL may pose an unacceptable risk without clarifying whether this is for individuals, populations, or both. Add clarifying language to these bullets.

61. Section 6.6.2; Page 6-12; Paragraph 5; Sentence 2

Stick to talking about the long-tailed vole and save discussion on the deer mouse for its own section. Revise accordingly.

62. Section 6.6.2; Page 6-13; Paragraph 4; Sentence 2

Stick to talking about the deer mouse and save discussion on the long-tailed vole for its own section. Revise accordingly.

Tables

63. Include a table that provides a summary of COC concentrations in monitoring wells.

64. Table 4-5. The highlighting for the seventh note listed should be removed.

65. Table 4-11. Describe whether these metals concentrations are for total or filtered analytical results. Considering these are for comparisons with MCLs or state groundwater standards, the appropriate comparison should be with total metals concentrations.

66. **Table 4-14.** There are a number of values listed as 0.000 or 0.0. Revise the table to show the correct significant figures.

67. **Table 4-16.** A note should be added that describes what the highlighted values in the table mean.

68. **Table 6-16.** EPA released new federal water quality criteria for selenium in June 2016 that no longer supports the previous 0.005 mg/L chronic criterion. The current federal WQC document recommends water-based lentic and lotic values of 1.5 and 3.1 µg/L, respectively, along with tissue-based. Revisions to the table are necessary to acknowledge the updated federal criteria for selenium.

69. **Table 6-16.** This table indicates that site-wide surface water exposure point concentrations (EPC) were used to evaluate risk to aquatic organisms. This may be appropriate for some upper trophic level receptor's exposure; however, amphibians, fish, and invertebrates will be exposed within a singular waterbody. The risk screening needs to be revised to be representative of the exposures to which aquatic organisms within specific waterways will be exposed.

Drawings

70. The geologic cross sections illustrate a dearth of groundwater monitoring wells, resulting in suspected/inferred groundwater elevations and flow directions. For example, sections B-B' and P-P' only have one monitoring well, and the others only show two monitoring wells. If possible, add more data to the cross sections, such as projecting other wells and sample results to form a more complete picture of the CSM and COC Fate andTransport.

71. Drawing 2-2

Change the symbol for MMW019 to represent a local aquifer monitoring well.

Change the symbol for MMW004 to represent a local aquifer monitoring well.

72. Drawing 2-3

Show the groundwater elevation in the Wells Formation.

The schematic groundwater flow vector in the Wells Formation' indicates downward flow, but text describes flow to the north. Is there a downward component of flow? If so, provide data to support this assertion. Similar comment for the Dinwoody Formation flow vectors – text (and Figure 5-3) describes possible flow to north along the axis of syncline, not eastward

The selenium concentration of 0.017 mg/L in MMW022 is from 2008. Yet the selenium concentration was approximately 0.045 mg/L in 2014. It is unclear why this drawing presents an older, lower concentration of selenium. Either provide justification for this, or update with the more recent concentration.

73. Drawing 3-3

Change the symbols for agricultural wells MAW004, 006 and 007 to represent agricultural wells.

Change the symbols for domestic well MDW0001 to represent a domestic well.

74. Drawing 4-11

Show interpreted flow directions for alluvial and bedrock groundwater flow systems.

For direct-push boreholes (BH) that exceed the selenium MCL, highlight or bold to demonstrate exceedances; alternately, shade the general impacted area.

Expand this drawing to the northwest to show the location of Henry Springs, and include sample results for Henry Springs (as this spring is described as a discharge for the Wells Formation).

Show other sample results (for example, results of MAW004, 006, and 007). These agricultural wells would appear to be important potential receptors.

MDW001 is shown, but no sample results are shown; according to Table 3-4, this well is not part of the sampling protocol. Add wells MDW003, MAW003, and MDW005 and include any sampling results.

75. Drawing 5-2

Based on this cross section, the Dinwoody Formation below MWD085 would be a very good placement for a monitoring well to evaluate COC migration from the waste rock into this aquifer.

Show the groundwater flow direction in the Wells Formation.

76. Drawing 5-3

Show the groundwater elevation and flow directions in the Wells Formation.

Add MPW022 and sample results.

Add MSP055 and sample results.

77. Drawing 5-3

Label the sliver of waste rock (?) overlying the Dinwoody Formation and Qw between Stations approximately between 1300 and 2000.

Note that having an additional Dinwoody Formation monitoring well north/northwest of this section, under MWD085, would allow for extending this cross section to the north to illustrate a larger picture of groundwater elevations and apparent gradient in the Dinwoody Formation, and provide a more complete CSM. As noted previously, lack of a Dinwoody Formation monitoring well under MWD085 is considered a data gap that should be addressed; see General Comment B for direction.

78. Drawing 5-4

Reference somewhere that Drawing 2-2 shows the location of Cross Section V-V'.

Appendix A – Risk Assessment

79. Appendix A; Page 2-2

Suggest additional bullet to BRA representativeness list:

- Human representativeness: Are surface soils and sediments sized to represent particles likely to adhere to skin and consequently ingested? If not, discuss as an uncertainty.

https://semspub.epa.gov/work/HQ/100000133.pdf

80. Appendix A; Page 3-1

Update risk estimates using the most recent version of the EPA Superfund Exposure

Factors (2014): https://www.epa.gov/risk/update-standard-default-exposure-factors

81. Section 3.1; Page 3-2; Paragraph 3; Last sentence

Add to Section 3.1 that EPA Regional Screening Levels (RSLs) (2015a) were also used in the screening process of constituents of potential concern (COPC) in surface and groundwater. Use the most updated citation of the RSLs (May 2016) if indeed values evaluated for the Henry Site are the same as EPA 2015 RSLs.

82. Section 3.1, Page 3-2, Paragraph 3

The National Recommended WQC listed is out of date. The most recently published version is July 28, 2016. Update reference accordingly in the text and tables throughout the report.

83. Section 3.1, Page 3-2, Paragraph 3

The EPA's RSL is out of date. The most recently published version is May 2016. Update reference accordingly in the text and tables throughout the report.

84. Section 3.3, Page 3-4, last paragraph.

As recommended by EPA's ProUCL software, the upper confidence limit (UCL) (95 percent or other) should be used as the EPC and not default to a maximum detected concentration (MDC) that is lower than that UCL. EPA no longer recommends defaulting to the MDC. The MDC is not recommended for risk assessment purposes because for small (for example, n < 10 to 20) or skewed data sets it does not provide the specified 95 percent coverage to the population mean, and for larger data sets it typically overestimates the EPC. If the MDC is below the UCL, then the question should be asked whether the data set is sufficient for risk assessment purposes and whether a data gap exists. While this situation may be unavoidable for some media (for example, as a result of limited numbers of culturally significant vegetation available to sample), the uncertainties it imposes on the risk estimate need to be fully discussed in the uncertainty section of the report. Looking at the EPC summary tables (Tables A3-8 through A3-14), it appears that the maximum detected value was only selected for culturally significant vegetation (CSV), which is unavoidable due to the limited availability of these plant types. Therefore, revise the text to indicate that the recommended UCL from ProUCL was used for all media except for CSV, which limited samples required defaulting to the maximum detected concentrations.

85. Section 3.3.1.2; Page 3-6; Paragraph 3

The document states: "A review of the USEPA's Exposure Factors Handbook (USEPA, 2011) indicates that only about 1% of inhabitants in the Western U.S. consume wild game, and less than 1% (i.e., 0.6%) of Native Americans consumes wild game. Furthermore, mean intake rates of wild game by Western U.S. residents and Native Americans are 0.012 grams per kilogram per day (g/kg-d) and 0.001 g/kg-d, respectively. In comparison, mean intake rates for 'total meats' by Western U.S. residents and Native Americans are 1.903 g/kg-d and 2.269 g/kg-d, respectively. As a result, wild game contributes only about 0.63% of the total meat consumed by Western U.S. residents and 0.044% of the meat consumed by Native Americans." The reviewer was not able to locate this information in the 2011 EPA Exposure Factors Handbook; please specify the table, chapter, or the study cited in this document that contains these assertions.

86. Section 3.3.1.2; Page 3-6

If the mean is the average of 1 percent of consumers and the 99 percent who don't consume, then this a misleading statement. Because the purpose of the risk assessment is to assess the risk to exposed people, it is inconsistent to estimate exposure factors by averaging rates of exposed and unexposed people. The risk to people consuming wild game must be based on *their consumption rate,* not the average of consumers and nonconsumers. Based on this text, it appears that game consumption rates were significantly underestimated. The consumption rate should be based on an upper percentile estimate of consumers; not a per capita estimate. The 2011 EPA Exposure Factors Handbook should be referenced to correct this value.

87. Section 3.3.1.2, P3-6, Paragraph 3

The wild game consumption rates provided in this section seem to be quite low for those populations that do consume wild game; these rates could not be located in the referenced document by this reviewer to verify. Provide additional information on where these rates were taken.

88. Appendix A; Page 3-8

Consider globally replacing "receptors" with "exposed" or "potentially exposed people."

89. Section 3.3.2.1, Page 3-11, last paragraph, last sentence

See previous comment regarding the MDC. EPA's ProUCL software, the UCL (95 percent or other) should be used as the EPC and not default to an MDC that is lower than the UCL. EPA no longer recommends defaulting to the MDC.

90. Appendix A; Page 3-12

Use the most recent version of ProUCL Software (v. 5.1) available at:

https://www.epa.gov/land-research/proucl-software

91. Section 3.3.2.2; Page 3-12

Suggest moving all this section as a new attachment (Exposure Estimation Equations for HHRA).

92. Appendix A; Page 3-24

Replace the outdated IRIS Uranium RfD with the ATSDR oral MRL value (see attached correspondence expressing support from EPA Head Quarters): http://www.atsdr.cdc.gov/toxprofiles/tp150.pdf

93. Appendix A; Page 3-27

The EPA preliminary remediation goal calculator can accept user-derived exposure or toxicity values included in the Particle Emission Factor.

94. Section 4.1.1.2; Page 4-2; Paragraph 2; After Line 11

It appears that not the same constituents were selected as constituents of potential ecological concern (COPEC) in upstream, downstream, and pond surface water. For example, cobalt, copper and thallium were selected in downstream and pond surface water, but not in upstream water (Table A4-3). Antimony was selected in upstream and pond surface water, but not in downstream surface water (Table A4-4). Please include an explanation in Section 4.1.1.2 for not selecting the same list of constituents in all surface water samples tested at the site (Tables A4-3 through A4-5).

Incorporate some text in this section regarding the final 2016 Aquatic Life Ambient Water Quality Criterion for Selenium in Freshwater and the fact that new values are available for lotic and lentic surface waters but that P4 used the draft value of 0.005 mg/L.

95. Section 4.2, Page 4-3, last paragraph, Sentence 1

Suggest removing the word "process" from this sentence so it reads more clearly.

96. Section 4.2.1.1, Page 4-4, Paragraph 2, Sentence 1

Suggest revising "Disregarding the influence of environmental contaminants …" to read as "Disregarding the influence of environmental contaminants and physical disturbance …"

97. Section 4.3.1; Page 4-21; Paragraph "Amphibian and Fish/American Goldfinch"

Although the methodology used to assess the risk of amphibians is appropriate, in the case of fish it would be more appropriate to use fish tissue data when available. It appears that some tissue data has been collected (Table 4-18); if the species of these forage fish (redside shiners, speckled dace) tissue concentrations are available then it would be valuable to incorporate these data in the ERA. Otherwise, an acknowledgement of the lack of this information and how this affects the overall risk assessment should be mentioned in the uncertainty section.

The HQ for the American goldfinch for silver is 0.12, so delete silver from the list of COPCs exceeding an HQ of 1.

98. Section 4.3.2; Page 4-24; Paragraph 3; Lines 2-5

Modify the text to read similar to: "Excess hazard associated with antimony in the Henry Mine upland soil was also calculated for deer mouse and mink; however, similar to the long-tailed vole, hazards associated with antimony in upland soil for these two constituents was greater at background location than at site."

99. Section 4.3.2; Page 4-25; Paragraph 2; Lines 2-5

Modify the text to read similar to: "Excess hazard associated with antimony in the Henry Mine upland soil was also calculated for long-tailed vole and mink; however, similar to deer mouse, hazards associated with antimony in upland soil for these two constituents was greater at background location than at site."

100. Section 4.3.2; Page 4-25; Last Paragraph

Change the range to 0.013 to 3.8 or revise the LOAEL-based value for thallium in Table A4-25.

101. Section 5.1; Page 5-1; Paragraph 4; Last Sentence

The document cites Table 7-4 of the Conda/Woodall Mountain Mine RI/FS Site-Specific Livestock Risk Assessment Problem Formulation (Formation Environmental, 2013). This citation is accurate; however, it would be more appropriate to cite the 2016 Final Livestock Risk Assessment Report Conda/Woodall Mountain Mine. Table 4-4 of this document has toxicity reference values for Evaluation of Drinking Water Ingestion by Livestock – Other Chemicals of Interest. Please cite this final document.

102. Section 5.2.1.1; Page 5-3; Paragraph "Livestock grazing"

It would be helpful to provide additional details in this section (for example, grazing allotment areas [if any], acreage of each allotment area, any restrictions in any of these grazing areas resulting from elevated selenium concentrations, and a map with the location of these grazing areas within the Henry Mine Site).

103. Section 5.2.1.2; Page 5-4; Paragraph "Terrestrial environment;" Last Line

This citation is partially accurate. "…adverse toxicity effects from toxicity adverse effects from toxicity may be reversed if the adverse effects did not include developmental deformities" could not be found in USDOI, 1998. Cite appropriate document or delete this portion of the text.

104. Table A3-1

- Change the nomenclature of the analyte Radium-226 to Radium-226+D in the analyte column and in note "d". The PRG value for Ra-226+D (radium+ daughter products) using the EPA's PRG calculator as a default for soil is 0.0063 picoCuries per gram (pCi/g); however the value for Ra-226 is 1.15E-02 pCi/g.
- The notes indicate: "All the concentrations in mg/kg except for radium-226, which is in picoCuries per kilogram (pCi/g)." There is an inconsistency in the units in the text and what is shown in parenthesis. Please change the text to picoCuries per gram.
- Note "b" has a typo.

105. Table A3-3

Note 3 needs to indicate that the RSL Resident Tapwater for carcinogens corresponds to a cancer risk of one in 1 million (TR=1E-06), and for noncarcinogens the HQ is equivalent to 1. Please provide the rationale for using an HQ of 1 for surface water instead of the HQ of 0.1 used in upland soil and sediments (Tables A3-1 and Table A3-4). This information should also be included in Section 3.1.1 (Surface Water) of Appendix A.

106. Table A3-3

This surface water screening inappropriately uses dissolved concentrations. The standards for protection of human health (DEQ's domestic use, and EPA's MCLs and PRGs) are based on total metals concentrations. The surface water screening tables should be revised to include total concentrations similar to that presented for groundwater.

107. Table A3-5

Footnote “f” (indicating that these constituents were eliminated from further consideration as a result of their low toxicity and being essential nutrients) is unnecessary since none of measured concentrations exceed screening levels, which is a better indicator of the protectiveness.

108. Table A3-6

Again, footnote “a,” which indicates surface water COPCs are all in the dissolved form except for selenium, is not correct. Total concentrations should be used for screening versus human health standards.

109. Table A3-13

The two occurrences of “surface water stations” should be changed to “sediment stations” since this is the sediment summary statistics table.

110. Table A3-30

Note “a” indicates that risk estimates for all COPCs are presented in Attachment C. Attachment C presents Tier I background and Human Health Risk Calculations, not Tier II calculations. Please change this reference to Attachment D.

111. Table A4-1

The column Lowest Soil Screening Level appears to have some inconsistencies. For example, the constituents arsenic, manganese, nickel, and silver are not the lowest concentrations from all of the screening values provided. Make appropriate changes or provide rationale for the selection of the lowest soil screening level in the table’s notes and in Section 4.1.1.1 of Appendix A.

112. Table A4-2

The column “Lowest Soil Screening Level” appears to have some inconsistencies. For example, nickel and silver are not the lowest concentrations from all the screening values provided. Make appropriate changes or provide rationale for the selection of the lowest soil screening level in the table’s notes and in Section 4.1.1.1 of Appendix A.

113. Table A4-3

Revise the hardness value used for the State of Idaho Standards Aquatic Life to 400 mg/L in note “a” to be consistent with statements in Section 4.1.1.2. Provide the reason(s) why cobalt was not included in the list of analytes in Table A4-3. This is inconsistent with the information presented in Table A4-7 (that is, cobalt is a constituent of potential concern in surface water).

114. Table A4-3

The EPA water quality criteria for aluminum, iron, and selenium are based on total concentrations. This table and any others using dissolved concentrations for aluminum and iron should be revised to include total concentrations for comparisons to these criteria.

115. Table A4-4

Revise the hardness value used for the State of Idaho Standards Aquatic Life to 256 mg/L in note “a” to be consistent with statements in Section 4.1.1.2.

116. Table A4-15

Section 4.2.1.1 indicates that plant tissue concentrations were based on measured concentrations, when available, instead of modeled concentrations. Add a footnote to this table that describes the modeled approach as being used only when sufficient data were unavailable for using measured tissue concentrations.

117. Table A4-21

Please provide the rationale for evaluating surface water data as one exposure unit. Although aggregating data for surface water and sediment over the entire site to calculate a 95% UCL of the mean may be appropriate for exposure to upper trophic level wildlife, it is not appropriate for exposure to fish and amphibian populations that are likely to be exposed within individual streams or ponds. The risk to aquatic resources (where present) using ponds and streams need to be evaluated independently.

118. Table 6-15 and Table A4-7

Note “b” - It would also be good to point out that the maximum manganese detected in soils at the Henry Mine Site (2,580 milligrams per kilogram [mg/kg]) is below the background level identified in MHW (2015) document (3,460 mg/kg) here and the text of the document.

119. Table B-27

The chemical-specific HQ for selenium (1.2E-01/5.0E-03) is 24, not 23. Please make appropriate changes in this table and throughout the document.

120. Table B-30

The chemical-specific HQ for thallium (1.3E-03/1.0E-05) is 130, not 128. Please make appropriate changes in this table and throughout the document.

121. Table B-42

The chemical-specific HQ for selenium (2.3E-01/5.0E-03) is 46, not 45. Please make appropriate changes in this table and throughout the document.

122. Table J-1

The ecological hazard for selenium (1.2/1.4E-01) is 8.6, not 8.2. Please make appropriate changes in this table and throughout the document.

Appendix C – Photographic Log

123. Appendix C; Page 1 of 6; Photo Location MST052

The sign in the photo indicates that this is site MST051. Reconcile.

Editorial Comments Table

Henry Mine

Editorial Comments

Item No.	Section; Table; Figure	Page	Paragraph	Line (if not obvious)	Agency/Tribe Comments	Did P4 Respond to Comment
	ES.4	ES-3	4 “Riparian Soil”	2	Delete second “investigations” as it is redundant.	
	ES.4	ES-3	3	Sentence 1	Insert “the” to read “… summary of the principal findings for the RI program …”	
	ES.4.1	ES-4	2	10	Delete “reclaimed” as it is redundant.	
	List of Drawings	ix	Drawing 5-2		There is no reference to this drawing in the text. Revise accordingly.	
	Acronyms and Abbreviations	xi			“ILCRs” is not in alphabetical order. Correct.	
	1.0	1-1	1	8	Insert “and” to read “… and the Shoshone-Bannock Tribes (Tribes).”	
	1.2.2.	1-4	Footnote	2	Delete “numeric” as it is redundant.	
	1.2.3	1-6	1 (partial)	4	Change to “Engineering Evaluation /Cost Analysis (EE/CA).”	
	1.2.3	1-6	2 (last)	1	Insert “into” to read “… entered into a new …”	
	2.3.2	2-5	5 (last)	1	Insert a comma to read “(i.e., MDS016).”	
	2.4	2-7	3 (last)	2	Insert a period to read “Oberlindacher, et al. (1982)” for consistency.	
	2.5.2	2-10	1 “Grasses”	1	Insert a space to read “*Bromus inermis*.”	
	2.6.2	2-13	3 (last)	3	Insert “road” to read “… P4 Enoch Valley haul road traverses …”	
	2.6.2.2	2-14	3 (last)	3	Insert “how” to read “… and ultimately how wells and …”	
	2.6.2.2	2-16	1	4	Insert “is” to read “… which is at a depth …”	
	2.6.2.2	2-16	1	Sentence 4	Change to read “The temperature data appear to respond to seasonal fluctuations …”	
	2.6.2.2	2-16	2 (last)	3	Insert a comma to read “… Enoch Valley Mine, is …”	

Item No.	Section; Table; Figure	Page	Paragraph	Line (if not obvious)	Agency/Tribe Comments	Did P4 Respond to Comment
	2.6.2.2	2-20	1 (partial)	4	Replace “and as” with “which” to read “… producing a “noisy” hydrograph, which is typical …”	
	2-7	2-21	1	3	Insert “in” to read “… discussed in the *Area-Wide Assessment* …”	
	2.10.1	2-24	3	2	Change to “Table 2-7.”	
	2.10.2	2-27	2	3	Change “freshwater criteria” to “surface water criterion.”	
	3.5	3-7	4	7	Change “Section 3.6.3” to “Section 4.6.3.”	
	4.3	4-15	2	6	Change “was” to “were” for subject-verb agreement to be consistent with the rest of the document where data is treated as plural. Check all instances to make sure this is consistent throughout the report.	
	4.4.1	4-23	3	2	Change “are exceeded” to “exceed” to read “… and often only exceed in one …” for easier reading.	
	4.4.1	4-24	1 (partial)	Sentence 2	Change to “exceeds” and “criterion” to read “… and there is only one sporadic or anomalous result that slightly exceeds the hexavalent chromium screening criterion, chromium is not discussed further.	
	4.4.2	4-26	2	5	Insert “spring” to read “… with spring exceedances of the selenium …”	
	4.4.4.1	4-29	2	6	Change to “criterion” to read the “… the screening criterion for cadmium …” Check the entire document for instances where the singular criterion should be used in lieu of the plural criteria.	
	4.4.4.1	4-30	1	3-4	Change to “criterion” for both occurrences.	
	4.4.4.1	4-31	2	Sentence 2	Delete “at” to read “Dissolved arsenic concentrations range from …”	
	4.4.4.2	4-31	3	Sentence 3	Change to “stations” to read “… for these stations are reported …”	
	4.5	4-34	5 (last)	3	Change “is” to “are” to read “Groundwater samples collected and analyzed from these wells are used …” for subject-verb agreement.	
	4.5.2.1	4-41	4 (last)	3	Delete “a” to read “… (SMCLs are used as reference points …”	

Item No.	Section; Table; Figure	Page	Paragraph	Line (if not obvious)	Agency/Tribe Comments	Did P4 Respond to Comment
	4.5.3	4-51	2	Sentence 2	Add a hyphen to read "… piper diagram – Figure 4-23 – to evaluate …"	
	4.6.1.2	4-56	4	3	Delete the comma after "soil" to read "… or potential species use, soil and vegetation selenium …"	
	5.1.1.1	5-3	2	6	Change "were" to "where" to read "Therefore, the areas where mass wasting …"	
	5.1.2.2	5-4	5 (last)	2	Should it be "Detail A1" as opposed to "Detail A?" Revise accordingly.	
	5.1.2.2	5-5	1 (partial)	2	Change to "Details B2 and B3)."	
	5.1.4	5-7	2	3	Change "affects" to "affect" for subject-verb agreement.	
	5.1.4	5-7	4 (last)	1	Change to "Sections 2.1 and 2.4."	
	5.1.4	5-7	4 (last)	6	Insert "and" to read "…bedding and is either …"	
	5.1.4.3	5-10	2	11	Insert "the" to read "… flow towards the northwest …"	
	5.2	5-13	3	1	Switch the period and quotation mark to read "analyte specific."	
	5.3.3	5-18	3 (last)	2	Change to "Little Blackfoot River."	
	5.3.3	5-16	4	1	Change "affect" to "effect."	
	5.3.3	5-20	3	3	Change to "concentrations."	
	5.3.4	5-20	3	6	Delete "a" to read "…events at MMW010)."	
	5.3.4	5-20	3	8	Add "they" and change to "exceed" to read "… and they rarely exceed background levels."	
	5.3.4.1	5-21	1	4	Insert "a" to read "… is a more significant pathway."	
	5.3.4.1	5-21	3	Sentence 4	Change to "…directed northerly toward the river and then to a more westerly direction …" as it seems to read more smoothly.	
	5.3.4.1	5-23	3 (last)	13	Change "verses" to "versus."	
	5.3.4.3	5-26	2	Sentence 1	Change "… flow path that experiences reducing conditions …"	

Item No.	Section; Table; Figure	Page	Paragraph	Line (if not obvious)	Agency/Tribe Comments	Did P4 Respond to Comment
	7.2.5	7-7	2	9	Change to “COC” to read “… as a preliminary COC for direct …”	
	7.2.6	7-8	5 (last)	1	Change “not affects” to “no effects.”	
	7.2.8	7-11	2	5	Insert a semicolon to read “… noncancer criterion”	
	7.2.9	7-13	3	11 (last)	This reader is not sure what is meant be “detected Site.” Revise.	
	7.3	7-14	4	1	Change to “These ecological risk estimates …”	
	Note 4	2-1			Change “of” to “for” to read “… accounts for the topography.”	
	Note Orange shaded	4-9		2	Change “levels” to “level” to read “Selenium action level is …” for subject-verb agreement.	
	Drawing 2-3				Reference somewhere that Drawing 2-2 shows the location of Cross Section B-B'.	
	Drawing 5-2				Reference somewhere that Drawing 2-2 shows the location of Cross Section P-P'.	
	Drawing 5-3				Reference somewhere that Drawing 2-2 shows the location of Cross Section N-N'.	

Stifelman, Marc

From: Scozzafava, MichaelE
Sent: Thursday, August 11, 2016 1:21 PM
To: Stifelman, Marc
Cc: Bachman, Brenda; Burgess, Michele; Kapuscinski, Rich
Subject: FW: R-X Uranium Request Update
Attachments: Uranium Response_Marc_ Stifelman_Final.pdf

Dear Marc,

My branch has reviewed the attached evaluation from the Superfund Technical Support Center (STSC) and have the following recommendations

EPA's 2003 hierarchy guidance (OSWER Directive 9285.7-53) encourages the use of the best science available when preparing human health risk assessments for the Superfund program. With the foregoing in mind, and in light of chemical-specific information and considering the scientific judgements of EPA staff toxicologists in the STSC, we believe you would be acting consistent with EPA guidance in using the ATSDR MRL for assessing the health risks of soluble uranium at your site.

This recommendation is based, in part, on the STSC evaluation that indicates the ATSDR MRL provides credible and relevant information that is more recent than the RfD currently available in IRIS. In addition, the ATSDR toxicological assessment indicated that, owing to regeneration of the renal tubule epithelium at low doses, continued exposure beyond an intermediate duration is not likely to induce more severe effects. ATSDR concluded, therefore, that the intermediate MRL (intended for exposures of 15-364 days) may be adequately protective for chronic exposures (defined as ≥365 days).

Consistent with existing EPA guidance on risk characterization, OSRTI recommends that Regions consider, on a case-by-case basis, the need to qualitatively characterize and address additional uncertainty inherent in using an intermediate duration reference value to assess chronic exposures.

If you have any questions, please don't hesitate to contact myself or Rich Kapuscinski of my staff.

Sincerely,

Mike

Michael Scozzafava, Chief
Science Policy Branch
OSRTI, OLEM
p: 703-603-8833
cell: (b) (6)

From: Jacklyn Toms [mailto:Toms.Jacklyn@epamail.epa.gov] **On Behalf Of** SUPERFUND STSC
Sent: Thursday, August 11, 2016 1:36 PM
To: Stifelman, Marc <Stifelman.Marc@epa.gov>

Cc: Shannon, Teresa <Shannon.Teresa@epa.gov>; Kaiser, Jonathan <Kaiser.Jonathan-Phillip@epa.gov>; Burgess, Michele <Burgess.Michele@epa.gov>; Gaines, Linda <Gaines.Linda@epa.gov>; CI NCEA STSC <CI_NCEA_STSC@epa.gov>; Scozzafava, MichaelE <Scozzafava.MichaelE@epa.gov>; Kapuscinski, Rich <Kapuscinski.Rich@epa.gov>
Subject: R-X Uranium Request Update

Superfund Technical Support Center
c/o U.S. Environmental Protection Agency
26 W. Martin Luther King Drive, MS A-G41
Cincinnati, OH, 45268
Phone: 513-569-7300; Fax: 513-569-7159
Email: Superfund_STSC@epa.gov
Supported by Highlight Technologies

Dear Marc,

Please see the attached response document from STSC Hotline Director Phillip Kaiser regarding an update to your request for an evaluation for using the recent ATSDR subchronic oral MRL in place of the outdated IRIS RfD for R-X Uranium. The attached memo has been revised based on discussions between OLEM and NCEA/STSC and supersedes the memo you received previously on 8/28/2015.

Please let us know if you have any further questions and thank you for contacting the STSC.

Sincerely,
Linda Horner
STSC

(See attached file: Uranium Response_Marc_ Stifelman_Final.pdf)

Superfund Technical Support Center

National Center for Environmental Assessment
U.S. Environmental Protection Agency
26 West Martin Luther King Drive, MS-AG41
Cincinnati, Ohio 45268

Phillip Kaiser/Hotline Director, Teresa Shannon/Administrator
Hotline 513-569-7300, E-Mail: Superfund_STSC@epa.gov

August 11, 2016

Marc Stifelman
EPA Region 10

ASSISTANCE REQUESTED: (Update) Evaluation of recent ATSDR sub-chronic oral MRL in place of outdated IRIS RfD for R-X Uranium.

ENCLOSED INFORMATION: Attachment 1:
Uranium Response_Marc_Stifelman_Final.pdf

If you have any questions regarding this transmission, please contact the STSC at (513) 569-7300.

Attachments (1)

cc: STSC files

Supported by Highlight Technologies, LLC, under
U.S. Environmental Protection Agency Contract No. EP-C-13-007

Regarding your request concerning soluble compounds of uranium, the available oral toxicity values can be found in Table 1 below. Currently there is a chronic RfD derived by the U.S. EPA's IRIS Program in 1989, an intermediate MRL derived by the ATSDR in 2013, and a chronic RfD derived by the U.S. EPA's Office of Ground Water and Drinking Water (OGWDW) from 2000. IRIS derived their chronic RfD using the 30-day toxicity study in rabbits conducted by Maynard and Hodge (1949) whereas ATSDR and OGWDW used the 91-day toxicity study in rats conducted by Gilman et al. (1998) as the principal study to derive their respective values.

The rabbit portion of the Maynard and Hodge (1949) study is limited in that only 6 rabbits (unknown sex/strain) were treated per dose group for 30 days and the only endpoints evaluated were mortality, gross pathology, clinical signs of toxicity, body weights, and kidney histopathology and the study did not present raw data for these evaluations. Compared to the Maynard and Hodge (1949) study, Gilman et al. (1998) is more recent (1998 versus 1949), tested a larger number of animals per dose group (15 rats/sex versus 6 rabbits/unknown sex), used a larger number of dose groups (6 versus 4), was of longer duration (91 days versus 30 days), and evaluated more endpoints: mortality, clinical signs of toxicity, food and water consumption, hematological and clinical chemistry parameters, organ weights, and complete histopathological exams. The Gilman et al. (1998) study tested a comprehensive list of endpoints, although the publication focused mostly on the reporting of kidney and liver effects. Overall, in response to your request, the STSC considers the Gilman et al. (1998) study reliable for hazard identification and dose-response assessment based on current standard U.S. EPA methodology and practice.

The STSC reviewed the ATSDR assessment for uranium with specific focus on the derivation of the intermediate-duration oral MRL. The STSC concludes that the intermediate-duration oral MRL for soluble compounds of uranium was derived using similar general assessment methods and procedures as those used by the IRIS and PPRTV Programs. However, there are quantitative differences between ATSDR methodologies and practice and EPA methodologies and practice which could result in the development of a quantitatively different reference value even when using the same study/endpoint. The ATSDR intermediate MRL value was peer-reviewed, published recently, and appears to be scientifically credible.

The U.S. EPA's Office of Ground Water and Drinking Water (OGWDW) derived a chronic RfD using the Gilman et al. (1998) study; the basis for this value is described in the *Radionuclides Notice of Data Availability Technical Support Document* (U.S. EPA, 2000). It is noted that OGWDW's chronic RfD was first discussed and finalized at an EPA-led workshop in 1998, and subsequently listed in the U.S. EPA's *2012 Edition of the Drinking Water Standards and Health Advisories* (U.S. EPA, 2012).

The STSC has no plans to develop a PPRTV assessment for uranium at this time because a chronic RfD for this chemical is currently available on the IRIS database. For questions regarding the existing IRIS chronic RfD for uranium, the IRIS Hotline can be reached by phone at (202) 566-1749 or by email at hotline.iris@epa.gov.

REFERENCES

ATSDR. (2013). Toxicological profile for uranium. In Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profiles. Atlanta (GA): Agency for Toxic Substances and Disease Registry (US).

Gilman AP et al. (1998). Uranyl nitrate: 28-day and 91-day toxicity studies in the Sprague-Dawley rat. Toxicological Sciences, 41:117–128.

Maynard EA, Hodge HC. (1949). Study of toxicity of various uranium compounds when fed to experimental animals. In: Voegtlin C, Hodge HC, eds. Pharmacology and Toxicology of Uranium Compounds. National Nuclear Energy Series, Div. VI, Vol. 1. New York: McGraw Hill, pp. 309-376.

U.S. EPA. (1989). Uranium, soluble salts; no CASRN. Integrated risk information system. Washington, DC: U.S. Environmental Protection Agency. https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/0421_summary.pdf

U.S. EPA. (2000). Radionuclides Notice of Data Availability Technical Support Document. (EPA/815/R00/007). Washington, DC: Office of Ground Water and Drinking Water.

U.S. EPA. (2012) 2012 Edition of the drinking water standards and health advisories [EPA Report]. (EPA/822/S-12/001). Washington, DC: Office of Water.

Table 1. Comparison of Toxicity Values for Soluble Uranium Compounds

Source	EPA-IRIS	ATSDR	EPA-OGWDW
Toxicity Value (Year Published)	Chronic RfD (1989)	Intermediate MRL (2013)	Chronic RfD (2000)
Critical Study	Maynard and Hodge 1949	Gilman et al. 1998a	Gilman et al. 1998a
Animal Species/Strain/Sex	6 rabbits/group (unknown sex/strain)	Sprague-Dawley rats; 15/sex/group	Sprague-Dawley rats; 15/sex/group
Study Duration	30 days	91 days	91 days
Compound Administered	Uranyl nitrate	Uranyl nitrate	Uranyl nitrate
Administered Dose	0, 0.02, 0.1 and 0.5% in the diet	0, 0.96, 4.8, 24, 120, and 600 mg/L in drinking water	0, 0.96, 4.8, 24, 120, and 600 mg/L in drinking water
Dose of uranium	0, 2.8, 14, and 71 mg U/kg-day	0, 0.06, 0.31, 1.52, 7.54, and 36.73 mg U/kg-day (males); 0, 0.09, 0.42, 2.01, 9.98, and 53.56 mg U/kg-day (females)	0, 0.06, 0.31, 1.52, 7.54, and 36.73 mg U/kg-day (males); 0, 0.09, 0.42, 2.01, 9.98, and 53.56 mg U/kg-day (females)
Endpoints evaluated in key study	Mortality, clinical signs of toxicity, body weights, kidney histopathology	Mortality, clinical signs of toxicity, food and water consumption, hematological and clinical chemistry parameters, organ weights, complete histopathological exams	Mortality, clinical signs of toxicity, food and water consumption, hematological and clinical chemistry parameters, organ weights, complete histopathological exams
LOAEL	0.02% in the diet (2.8 mg U/kg-day)	0.96 mg/L in drinking water (0.06 mg U/kg-day)	0.96 mg/L in drinking water (0.06 mg U/kg-day)
Effects identified at the LOAEL	Transient reduction in body weight (not specified); moderate nephrotoxicity (histopathological effects on the tubular epithelium)	Renal histopathology (cytoplasmic vacuolization, tubular dilation, and lymphoid cuffing in males, capsular sclerosis, tubular anisokarytosis, and interstitial reticulin in females, and nuclear vesiculation in both sexes)	Renal histopathology (cytoplasmic vacuolization, tubular dilation, and lymphoid cuffing in males, capsular sclerosis, tubular anisokarytosis, and interstitial reticulin in females, and nuclear vesiculation in both sexes)
Effects at doses higher than the LOAEL	Mortality (two highest doses)	Additional changes in kidney histopathology; lesions of the liver, thyroid, and/or spleen	Additional changes in kidney histopathology; lesions of the liver, thyroid, and/or spleen
NOAEL	Not determined	Not determined	Not determined
Approach used	NOAEL/LOAEL	NOAEL/LOAEL[a]	NOAEL/LOAEL[a]
Composite UF	1000[b]	300[c]	100[d]
Toxicity Value	0.003 mg U/kg-day	0.0002 mg U/kg-day[c]	0.0006 mg U/kg-day

[a] Benchmark dose (BMD) models did not provide an adequate fit to the incidence data for kidney lesions.

[b] The composite UF of 1000 is based on 10 for UF_H, 10 for UF_A, and 10 for UF_L. The composite UF does not include 10 for UF_S because the acute/subchronic toxicity study is considered adequately sensitive for chronic nephrotoxicity.

[c] The composite UF of 300 is based on 3 for UF_L (use of a minimal LOAEL, since histopathological changes at 0.06 mg U/kg-day were considered minimally adverse), 10 for UF_H, and 10 for UF_A. The ATSDR assessment indicated that chronic data are not sufficient to derive a chronic MRL, but that, owing to regeneration of the renal tubule epithelium at low doses, continued exposure is not likely to induce more severe effects. ATSDR concluded that the intermediate MRL (intended for exposures of 15-364 days) may be adequately protective for chronic exposures (defined as ≥365 days) (Note: ATSDR does not extrapolate across exposure durations).

[d] The composite UF of 100 is based on 3 for UF_L, 10 for UF_H, and 3 for UF_A. It was noted that EPA followed the recommended methodology of the National Academy of Sciences in estimating the uncertainty factor (no further rationale was provided in the *Federal Register* notice about the Final Rule).

Acronyms: LOAEL = lowest observed adverse effects level; MRL = Minimal Risk Level; NOAEL = no observed adverse effects level; OGWDW = Office of Ground Water and Drinking Water; UF = uncertainty factor; UF_A= uncertainty factor for animal-to-human extrapolation (inter-species variability); UF_H = uncertainty factor for human (intra-species) variability; UF_L = uncertainty factor for use of a minimal LOAEL.

Supported by Highlight Technologies, LLC, under
U.S. Environmental Protection Agency Contract No. EP-C-13-007

APPENDIX D-2

P4 Responses to A/T Comments (dated December 19, 2016) on *P4's Henry Mine Remedial Investigation Report, Draft Rev 0, August 2016*

Submitted to A/Ts on February 6, 2017

From: Drain, Vance <vance.drain@stantec.com>
Sent: Monday, February 06, 2017 3:55 PM
To: Vance Drain; Tomten.Dave@epamail.epa.gov
Cc: Bruce Narloch; bruce.olenick@deq.idaho.gov; eldine.stevens@bia.gov; gbillman@idl.idaho.gov; jcundick@blm.gov; Colleen O'Hara (cohara@blm.gov); Jeff Schut; jeffrey.fromm@deq.idaho.gov; Kelly Wright (kwright@shoshonebannocktribes.com); Edmond.Lorraine@epamail.epa.gov; VRANES, RANDY K (AG/1850); robert.blaesing@bia.gov; sherriaclark@fs.fed.us; (b) (6) michael.rowe@deq.idaho.gov; Jeff Schut; Sandi_Fisher@fws.gov; Trina Burgin; Marc Stifelman ; Cary Foulk (cfoulk@integrated-geosolutions.com); Leah Wolf-Martin (leah@wolfmartininc.com); COOPER, RANDALL LEE [AG/1000]; Dennis Smith (dennis.smith2@ch2m.com); LEATHERMAN, CHRIS R [AG/1850]; MOLLY PRICKETT [AG/1850]; Paula Weyen-Gellner; Anthony Magliocchino; Barry Myers (bmyers@blm.gov); Shannon Leigh Ansley (sansley@sbtribes.com); Jeremy Moore (jeremy_n_moore@fws.gov); Stumbo, Sherri A -FS; Norka Paden (Norka.Paden@deq.idaho.gov)
Subject: P4's Responses to A/T comments on the Henry RI/BRA Report and associated attachment
Attachments: P4 Responses to A_T Henry Mine RI comments (02-06-2017)_.docx; P4 Responses to A_T Henry Mine RI comments (02-06-2017)_.pdf; Ralston Wells Formation Memo Review_5-24-10.pdf

Dave et. al.,

Attached are P4's responses to your comments on the *Henry Remedial Investigation (RI)/Baseline Risk Assessment (BRA) Report –Rev 0* that were originally submitted to P4 on December 19, 2016. We are providing these comments in both pdf and word files so they can be easily reviewed and edited. Also attached is Dr. Ralston's 2010 memorandum that is associated with our response to Specific Comment SC-8.
Please let us know if you have any additional questions or concerns before we edit this document based on our responses, and submit the next version of the *Henry RI/BRA Report*. Thank you.

Best Regards,

Vance Drain
MWH PM P4/Monsanto
801 617 3250

A/T Comments and P4's Responses
Henry Mine Remedial Investigation (RI) Report
(Revision 0, August 2016)

General Comments

A. Several portions of this report refer the reader back to the Blackfoot Bridge Environmental Impact Statement (EIS). Although referencing the report is valid, this report should be a stand-alone document, not one that relies on an EIS from another mine site. Please revise the Remedial Investigation (RI) report and for those discussions that refer to the EIS, add the appropriate discussions so that it is unnecessary for the reader to read the EIS or the Ballard RI report.

   P4 Response (GC-A)*: This <u>Henry RI Report</u>, much as any other scientific publication relies on previous findings to confirm or further its scientific assumptions/conclusions. The technical documents referenced in the <u>Henry Remedial Investigation Report (Henry RI Report)</u> are included to provide additional relevant technical information from other locations within the P4 property boundaries or Southeastern Idaho Phosphate patch. They are used to support our positions/conclusions based on information collected from other nearby locations where the geology, hydrogeology, environmental setting and conditions, etc. are similar. Where necessary, information from previous studies has been added to the text for clarification.*

B. Overall, contaminants of concern (COC) in groundwater appear to be largely below maximum contaminant levels (MCL) and not migrating offsite. The COC concentrations also appear to be relatively stable, but respond to large snowmelt events (in particular, the above-average snowpack of 2011). However, data gaps in monitoring groundwater are identified in appropriate sections and on the drawings. The report contains numerous speculative statements such as "it is possible" or "probably flows" or "likely" or "either to the northwest or southeast." Statements such as these suggest to reviewers that questions, uncertainties, and data gaps still exist in the site characterization and undermine the conceptual site model (CSM). Revise statements to be more conclusive, or provide additional data or interpretation to eliminate the need for speculation. In addition, several specific comments note potential data gaps with respect to groundwater characterization, and raise questions about the adequacy of the well networks for determining groundwater flow direction and fate of contaminants. In addressing these comments, please identify uncertainties, discuss amount and type of information necessary to support remedial decision making, and identify potential data gaps that must be addressed at the RI stage of the process.

   P4 Response (GC-B)*: These statements have been reviewed on a case-by-case basis and revised as needed. Because these are complex natural systems, there will always be some uncertainty. We have attempted to be more definitive and/or qualify the uncertainty where it is possible.*

C. In general, Appendix A of the report is well prepared and is likely to support future remedial decisions. However, it would benefit from revisions to reference the most current U.S. Environmental Protection Agency (EPA) data sources and software. Although risk assessments generally default to protective assumptions to address unknown uncertainties, the toxicity values for arsenic and uranium are notable exceptions. For arsenic, the current cancer slope factor underestimates the risk of internal cancers, but a replacement value is not currently available. For uranium, the recent oral Minimal Risk Level (MRL) prepared by ATSDR is recommended as a superior alternative to the outdated IRIS Reference Dose (RfD) (see attached).

***P4 Response (GC-C)**: The cancer slope factor for arsenic is based on the current EPA value and, because no replacement value is available, this toxicity value was not changed in the revised document. Uncertainty associated with the evaluation of arsenic can be discussed in the uncertainty section of the BRA, as needed, following additional discussion on this topic with the USEPA reviewer.*

The uranium intermediate MRL (ATSDR, 2013) was available at the time the A/T instructed P4 to use the USEPA Office of Groundwater and Drinking Water (OGWDW) (2000) uranium RfD in October 2014. For consistency with prior direction from the A/T on a recommended RfD for uranium, and for consistency with the Ballard Site BRA, the RfD has not been updated.

D. The EPA has recently released the 2016 Aquatic Life Ambient Water Quality Criterion for Selenium in Freshwater. This document provides chronic values for lotic, lentic waterbodies, and selenium in fish tissue whole body and egg/ovary, and reflects the best available science. Although these changes have not been adopted by the State of Idaho, they are Relevant and Appropriate Requirement [ARAR]). Please revise appropriate tables. In addition, EPA recently disapproved the State of Idaho's water quality criterion for Arsenic for the protection of human health. The relevant and appropriate requirement should be revised from 10 to 6.2 ug/l.

***P4 Response (GC-D)**: The text, tables, and drawings have been revised to incorporate the USEPA selenium and arsenic criteria. Please note that the reduction in both criteria will have little to no effect on the drawings and tables (e.g., only at MDS034 will the minimum value now exceed the arsenic criteria on Drawing 4-9). It certainly will not affect the risk assessment or nature and extent of findings as presented in the <u>Henry RI Report</u>.*

E. Volatile organic compounds (VOCs) are not in the list of COPCs for the Henry Mine Site and the human health conceptual site model (Figure 6-1) does not include inhalation as a route of exposure for groundwater. Thus, delete the VOC inhalation concentration column from tables in attachments B, C, D and E of Appendix A, or provide a rationale for using VOC inhalation concentration for groundwater exposure of future residents and future seasonal ranchers in the text and table notes.

***P4 Response (GC-E)**: The VOC concentration and VOC risk columns in the referenced tables are populated with "NA" consistent with the conceptual site model for this Site. However, for clarity, these columns have been removed*

F. Conclusions of Appendix A, as written, provide a good summary of the Baseline Risk Assessment (BRA). This section would benefit from emphasizing the objectives of the BRA, along with providing concluding statements regarding unacceptable risks associated with specific areas of Henry Mine Site, and major risk drivers for the Human Health Risk Assessment (HHRA), Ecological Risk Assessment (ERA), and Livestock Risk Assessment.

***P4 Response (GC-F)**: The BRA conclusions in Appendix A have been revised to restate the objectives of the BRA and identify the most significant risk drivers. A text discussion of specific areas of the Henry Site that are associated with excess risk is beyond the scope of the Henry Site BRA because the risk assessment only evaluated Site-wide EPCs. This request would be more easily accommodated in the FS for the Henry Site that will be prepared following acceptance of this RI document.*

G. Tables in Appendix A have some inconsistencies in the calculations of hazard quotients (HQ) and ecological hazard values. These calculations won't affect the final conclusions of the BRA; however, it would be good to revise all the calculations in the tables for accuracy and consistency in rounding decimals.

***P4 Response (GC-G)**: Inconsistencies result from displaying rounded numbers in formatted tables but carrying unrounded values through the calculation to the final HQ. Please refer to responses to SC-119 through SC-122.*

Specific Comments

Report

1. Section ES.4.1; Page ES-4; Paragraph 1 (partial); Sentence 3 (last)

Reword this sentence beginning "Depending on how the site …" as it reads awkwardly.

***P4 Response (SC-1)**: The sentence has been revised as follows: "Depending on Site conditions, water can continue downward through the mine dumps and infiltrate into the underlying shallow groundwater. This water then will be present either as seeps or springs further downslope, or as shallow alluvial groundwater plumes downgradient of the mine waste rock source areas."*

2. Section ES.4.1; Page ES-4; Paragraph 2; Sentence 4

Change to "Upland soil collected primarily from the soils developed on the graded and reclaimed waste rock dumps comprises …"

***P4 Response (SC-2)**: This edit has been made in the revised report.*

3. Section 1.2.2; Page 1-5; Henry Mining and Reclamation History, second paragraph, 5th sentence

Please clarify, does "As a result, most of the mine pits have been backfilled, graded to promote storm water drainage away from the pit backfill, and were covered and seeded to prevent erosion," mean that the storm water is draining into the pit or away from the pit? What does "away from" mean?

***P4 Response (SC-3):** The sentence is intended to mean that storm water drainage is conveyed away from the backfilled and reclaimed mine pits. The sentence has been revised as follows: "As a result, most of the mine pits have been backfilled, graded to promote storm water drainage away from the backfilled mine pits and into intermittent drainages located down slope, then covered and seeded to prevent erosion."*

4. Section 2.5.2; Page 2-10; Vegetation, second bullet

This section describes milk-vetch as a Group 1-primary selenium accumulator species without discussing what Group 1 means, or directing the reader to a table with this information. Please revise for clarification.

***P4 Response (SC-4)**: The bullet has been revised to reference NRC, 1983 listed below and the Soil and Vegetation Technical Memorandum (MWH, 2009) for the selenium accumulator species.*

<u>National Academy of Science-National Research Council. 1983. Selenium in nutrition. Rev. ed. Board on Agric. NAS-NRC, Washington, DC</u>.

5. Section 2.5.2, Page 2-10, last bullet

Reference where the list was obtained for which plant species were considered as culturally significant plants during the vegetation sampling/survey.

***P4 Response (SC-5)**: The following text has been added to end of the first paragraph in Section 2.5.2: "Culturally significant plant species also were identified as part of the survey. The species list was provided by the A/T and documented in the A/T-approved sampling plan (<u>Culturally Significant Plant</u>*

Sampling Henry, Ballard, and Enoch Valley Mine Sites Late Summer/Fall 2009 Technical Memorandum [MWH, 2009b]).”

MWH, 2009b. Culturally Significant Plant Sampling Henry, Ballard, and Enoch Valley Mine Sites Late Summer/Fall 2009. Technical Memorandum to Mike Rowe, IDEQ, from Cary Foulk and Randy Walsh, MWH. August.

6. Section 2.6.1; Page 2-11; Regional Hydrogeology

Text states, “The alluvial groundwater typically is *unconfined* by lower permeability layers.” Lower permeability layers typically confine groundwater? Check wording and revise if necessary.

P4 Response (SC-6)*: The sentence has been revised to simply say, “The uppermost alluvial groundwater typically is unconfined based on the boreholes and monitoring wells installed at the Site, and therefore, the water table surface and groundwater flow generally mirrors and follows the surface topography”.*

7. Section 2.6.2.2; Page 2-19; Piezometric and Temperature monitoring

Text states “it is possible there is increased loss from the river to the Wells Formation during high flow events, and this is an area of significant recharge….” This is a potential data gap. To confirm or refute this assertion, streamflow measurements up and down from where the Little Blackfoot River (LBFR) crosses the Wells Formation could be conducted. If the LBFR creates significant recharge to the Wells Formation, and the river becomes impacted by COCs, then this is an important component of the CSM that must be addressed.

P4 Response (SC-7)*: There are several points to consider. First, flow measurements may not have the resolution to see the flow loss, especially during high-flow events because the potential measurement error is often relatively large. Second, COC/COEC concentrations in this area along the LBFR have rarely exceeded screening criteria for either surface water or groundwater. The surface water screening level for selenium has been exceeded at the surface water sampling station MST044, but in only 2 of 14 events did selenium concentrations in the river exceed the surface water screening criteria (0.0031 mg/L), and the groundwater selenium MCL (0.05 mg/L) has never been exceeded in the river. Third, selenium and other COC/COEC concentrations in the river are not trending upward, and there is no reason to suspect they will be given that the Henry Mine is reclaimed and closed over large areas. Finally, the piezometric hydrograph for MMW011, especially in association with high flow events, is indicative of the recharge, and for this reason the sentence in question has been revised to say:*

“The Little Blackfoot River crosses the Wells Formation near MMW011, and the hydrograph from this monitoring well indicates increased loss from the river to the Wells Formation especially during high flow events. This portion of the river corridor is believed to be an area of recharge to the formation.”

8. Section 2.6.2. 2; Page 2-19; Piezometric and Temperature monitoring

a. Text states “MWs MMW011 and MMW023 are on the *conceptual* flow line in the Wells Formation that is *assumed* to terminate at the Henry Springs…” [italics added]. Two wells with 10 feet of water level difference do not necessarily define a groundwater flow direction. An apparent gradient to the north does not mean the groundwater flows north; just that there is a possible northward component of overall flow. Data from nearby mine sites indicates that the gradient and flow direction in the Wells Formation is generally more to the west. Defining the flow direction and gradient in the Wells Formation is an important part of the Site Characterization and CSM. See also 2010 technical memorandum on this topic that was re-circulated recently.

b. Was, or is, the Henry Spring being sampled or monitored? Has the discharge from this spring been chemically "typed" and compared with Wells Formation water? Have site COCs been detected? Please provide data. If this spring is downgradient from the site and discharges Wells Formation groundwater, data from this spring are important to the CSM and COC Fate and Transport (F&T).

P4 Response (SC-8):

a) The concept of westward flow in The 2010 A/T technical memorandum (2010 tech memo), was discussed and commented on during the scoping and development of the <u>Final Remedial Investigation/Feasibility Study Work Plans for P4's Ballard, Henry and Enoch Valley Mines (RI/FS Work Plan; MWH, 2011)</u>. We also have attached the response to the 2010 A/T Tech Memo that was prepared by Dr. Dale Ralston, P.G., P.E., Professor Emeritus of Hydrogeology, University of Idaho. Dr. Ralston has researched and published many scientific papers on groundwater flow in SE Idaho. The hydrogeologic condition of the regional aquifer also is summarized in Section 5.1.4.3 of this <u>Henry RI Report</u>, and is discussed in more detail in the <u>RI/FS Work Plan</u>, notably Section 3.7.4.3 and associated comments and responses in Appendix F.

As summarized by Dr. Ralston in his response to the A/Ts' 2010 Tech Memo, regional flow patterns cannot be determined based on widely-spaced potentiometric measurements in the structurally and lithologically complex geologic terrain of SE Idaho as suggested by the 2010 A/T Tech Memo (i.e., piezometric measurements separated by major geologic and geographic features cannot be used to project local groundwater flow patterns). The groundwater flow in the regional aquifer at the Site is in Wells Formation (refer to the Drawing 2-2 and Section B-B' geologic map), which is on a steeply dipping limb of a syncline oriented along a northwestern/southeastern line. The groundwater flow relevant to the Site is in poorly cemented sandstone units of the upper Wells Formation. Significant westward flow in the Wells Formation at the Site is very unlikely as this would be across bedding, which would necessitate groundwater movement through lower permeability limestone beds of the Wells Formation. Groundwater flow is similarly restricted in an eastward direction by the low permeability Meade Peak Member of the Phosphoria Formation. Thrust faults to the east and west also bound and compartmentalize the regional groundwater flow system.

Flow to the northwest in the Site area was first put forth in by Dr. Ralston in 1983 (Ralston, et. al., 1983). The presence of the Henry Springs (nearby to the northwest – Drawing 2-1) is strong evidence of northwest flow in the regional aquifer within the hydrogeologic block bounded by the roughly parallel Henry Thrust and the Slug Valley Faults (refer to Drawing 2-2). The Henry Springs are a recognized regional discharge point for the Wells Formation and the regional aquifer (Mayo. 1982; Ralston, et. al. 1983). This northwestern flow direction is further supported by potentiometric measurements collected during the P4 RI from MMW011 and MMW023 that indicate a northwest flow gradient in the uppermost Wells Formation sandstones at the Site (Drawing 2-2 also shows the locations of these monitoring wells). These potentiometric measurements are collected from the upper beds of the Wells Formation on the western syncline limb (i.e., in a continuous hydrostratigraphic unit). Flow to the southeast in the Wells Formation is impeded by the east-west trending Rasmussen Fault (refer to Drawing 2-2) along the southeastern margin of the Site.

Finally, any monitoring well or piezometer installed at a reasonable depth perpendicular to the line between MMW011 and MMW023 would be in steeply dipping hydrogeologic units either up or down the geologic section as shown in Drawing 2-2 and possibly separated by a steeply dipping aquitard, such as the Meade Peak Member of the Phosphoria Formation or lower permeability beds of the

Wells Formation. Any piezometric (water level) measurements from these locations would not be indicative of the groundwater flow in the upper sandstone beds of the Wells Formation that are most likely to be affected by the Site.

b) The Henry Springs and the regional aquifer are discussed in Mayo (1982) and Ralston, et. al. (1983). They were not sampled as part of the P4 RI/FS investigations and COC data are not available although general water quality are available in Mayo (1982). However, note that MDW005 is installed in the same area as the Henry Springs and has been sampled for water chemistry and COCs during the P4 RI. Data from MDW005 have been included in the revised Henry RI Report and based on general water quality appears to be similar to the springs. Mayo (1982) dates the water discharging from the springs are in excess of 10,000 years old (i.e., 20,500 years old). However, this is an average age, and discharging spring water may include younger and older contributions. This older date suggests that if any Site water were to have reached the springs, significant dilution and attenuation undoubtedly would have occurred. Any signature or COCs from the Site are not likely to be distinguishable in the discharge because of this dilution (discharge from the springs was approximately 5,000 gpm in 1980 [Ralston et. al., 1983]). The sampling reported in Mayo (1982), and discussed further in Ralston, et. al. (1983), verifies that the water discharging at the Henry Springs is regional aquifer water, of which the Wells Formation is the major component. Other deeper limestone units (Brazer and Madison Limestones) may also contribute some flow. The following discussion has been added to the end of Section 2.6.2.2:

> *"The Henry Springs discharge at an elevation approximately 6,135 feet AMSL, or approximately 20 feet lower than the water level in MMW023. They have formed a large area of travertine located approximately 1 mile west of the northern portion of the Site (Drawing 2-2). The springs and associated flow system were sampled and evaluated by Mayo (1982) and Ralston, et al. (1983). Sampling for the major ions indicate that the water discharging from the springs is a highly evolved calcium-carbonate water type discharging from the Wells Formation. The sulfate content of the springs is low, averaging approximately 50 mg/L. The water discharging from one of the springs was dated at 20,500 years old (Mayo, 1982). The flow volume (> 4,000 gpm), chemistry, and age date indicate this is groundwater discharge from a large portion of the Wells Formation (which represents a large area) and other regional aquifer formations."*

9. Section 2.7; Page 2-21; Paragraph 2 (last); Line 7-8

Use of the term leeward is usually associated with wind. Use direction (for example, north and east) or indicate the prevailing wind direction at the site. Please clarify.

***P4 Response (SC-9)**: The sentence has been revised as follows: "Forested land (dominantly conifers) is primarily located near the southern end of the Site."*

10. Section 2.9; Page 2-23; Paragraph 5 (last); Sentence 4

Confirm the date on the establishment of the Fort Hall Reservation, as 1863 would be 5 years prior to the signing of the treaty in 1868.

***P4 Response (SC-10)**: The date has been changed to 1868 in the revised report. Although note there are online references cite the date back to the original 1863 date as provided in the websites below.*

http://www.sbtribes-ewmp.com/land_base_fort_hall.html

http://www.nrcprograms.org/site/PageServer?pagename=airc_res_id_forthall

11. Section 2.10.1; Page 2-24; Phosphoria Formation, first paragraph:

The discussion indicates that there are "naturally elevated background concentrations that result in elevated concentrations of some elements downslope of Meade Peak outcrops in soils and also likely in stream sediment, and possibly downgradient in groundwater and surface water." According to the tables provided in the P4 Background Tech Memo FINAL-Rev 0_March 2013, none of the sediment, surface water or groundwater samples exceeded the screening level for selenium, the site driver. The only elevated selenium samples this reader observed in the background data was for approximately eight soil samples. It appears that the statement made is unsupported by the data, and should be re-phrased to specify which elements you are considering in the statement; bring in the data from the background tech memo for the reader to review.

***P4 Response (SC-11)**: Upland soil background samples initially collected during the RI, as presented in the Background Levels Development Technical Memorandum (2013 Background Levels Tech Memo; MWH, 2013), represent only a portion of the potential area disturbed by the historic mining operations, and did not include soils derived from, and overlying, the Phosphoria Formation. A supplemental soil background study was performed in fall 2014 as detailed in the On-Site and Background Areas Radiological and Soil Investigation Summary Report (2015 Background and Radiological Report, MWH, 2015).*

The 2014 background samples were collected from upland soils overlying the three primary geologic formations including the Phosphoria Formation (Meade Peak and Rex Chert Members) at an undisturbed or natural portion of the Blackfoot Bridge Mine and at Caldwell Canyon. These data were combined with the 2009 upland soil background sampling to develop representative background values for upland soils. The reviewer should become familiar with this study and its findings as the upland soil background concentrations collected in 2014 from the Phosphoria Formation are elevated in several constituents. The resulting 2015 95-95% UTL values for individual COCs/COECs (used for upland soils screening) range from approximately 1.5 to 200 times higher than the 2013 95% USL upland soil background values as shown in the table below.

As noted in the Henry RI Report and the 2015 Background and Radiological Report, representative background samples for sediment, riparian soil/vegetation, surface water, and groundwater have not been collected from native areas downslope/downstream of the Phosphoria Formation. Based on the elevated upland soil constituents detected in 2014, it is plausible that background samples collected downslope/downstream of undisturbed/native pre-mined Phosphoria Formation would result in elevated concentrations in these media as well.

Upland Soil	2013 Background Value (95% USL)	2015 Background Value (95-95 UTL)	Factor Increase
Antimony	0.745	**3.60**	4.8
Arsenic	11.5	**15.6**	1.4
Cadmium	8.6	**41.0**	4.8
Chromium	32.7	**410**	12.5
Copper	37.5	**51.9**	1.4
Molybdenum	3.45	**29.0**	8.4
Nickel	37.8	**220**	5.8
Radium-226	NA	**15.1**	NA

Upland Soil	2013 Background Value (95% USL)	2015 Background Value (95-95 UTL)	Factor Increase
Selenium	1.80	**29.0**	16.1
Thallium	0.288	**1.10**	3.8
Uranium	1.61	**36.0**	22.3
Vanadium	1.61	**300**	185.9
Zinc	173	**1,200**	6.9

12. Section 2.10.1; Page 2-24; Paragraph 3; Line 4

This sentence implies that all constituents are elevated in soils overlying undisturbed and pre-mined areas of Meade Peak Member. If memory serves, background concentrations at Caldwell Canyon did not differ much from background concentrations observed at other formation/member outcrops (Dinwoody, Wells). Insert a qualifier in this sentence; perhaps, "Please note that for some undisturbed and pre-mined areas …"

> ***P4 Response (SC-12)***: *The sentence was not meant to imply that all constituents are elevated in soil overlying undisturbed and pre-mined areas of the Meade Peak Member. P4 refers the reviewer to Table 3-11 from the 2015 Background and Radiological Report (MWH, 2015), which shows at both Caldwell Canyon and Blackfoot Bridge that a majority of the COCs/COECs including cadmium, chromium, copper, molybdenum, nickel, selenium, thallium, vanadium, uranium, zinc, and radium-226 reported the highest concentrations in the soil samples collected from the Phosphoria Formation (primarily the Meade Peak Member). Based on these 2015 findings, no revision to this sentence is necessary.*

13. Section 2.10.1; Page 2-25; Phosphoria Formation

Rather than referring to another report, please provide a summary table that shows elemental concentrations in the Meade Peak Member to assist in comparisons.

If background concentrations are naturally elevated, please cite the document reporting this information, provide a summary of background concentrations, and identify COCs that are truly elevated as a result of activities at the Henry Mine.

> ***P4 Response (SC-13)***: *The report has been revised to include a summary of the elemental concentrations in the Meade Peak Member. This will include a version of Table 2-7 included in the Final Ballard RI Report (November 2014).*
>
> *As discussed in response to SC-11 above, elevated background concentrations in soils overlying the Phosphoria Formation are well documented in the 2015 Background and Radiological Report (MWH, 2015), which is referenced twice in Section 2.10.1. Upland soil background concentrations and a summary of elevated COCs/COECs are provide in Table 4-1, as well as Appendix B Table B-1a, and are discussed in Section 4.1.*

14. Section 2.10.2; Page 2-28; Paragraph 1 (partial); Sentence 2 (last)

Explain why data from South Rasmussen Mine (SRM), in particular, will be useful for establishing hydrogeologic characteristics for a location with uncovered center waste shale. The area of study at SRM is a waste rock dump that is covered.

P4 Response (SC-14)*: Note that O'Kane started monitoring an area of uncovered CWS on the Horseshoe Overburden Facility at South Rasmussen in 2008. However, the last paragraph of Section 2.10.2, pages 2-27 and 2-28 has been revised as follows: "In 2007 and 2009, site locations were instrumented with a network of moisture sensors (e.g., time domain reflectometry or TDR sensors) including P4's South Rasmussen Mine. Data from this site and the other sites monitored by O'Kane Consultants (O'Kane, 2009a and 2009b) may be useful in establishing hydrologic characteristics of various cover configurations that occur at the three P4 Sites, including various thicknesses of soil and rock cover."*

15. Section 3.5; Page 3-4

There is a potential data gap in surface water sampling locations along the Little Blackfoot River, between MST044 to the confluence with Long Valley Creek/Long Valley Creek Tributary.

P4 Response (SC-15)*: P4 does not believe there is a characterization data gap for surface water along this segment of the Little Blackfoot River (LBFR) because are no sources of P4 contamination that would affect the LBFR downstream of the MST044 monitoring station. Additionally, both monitoring wells MMW011 (Wells Formation) and MMW019 (Alluvial/Phosphoria Formation) located further downstream (i.e., west of MST044) and near the LBFR are not impacted.*

16. Section 4.1.3; Page 4-5; Paragraph 3; Sentence 3

Change to "However, as seen on Table 4-1, most of concentrations are within about two times the background level."

P4 Response (SC-16)*: Agreed. The revised RI report contains this change.*

17. Section 4.1.4.2; Page 4-7; Paragraph 3; Sentence 4

Delete "with a mean of 4.04pCI/m^2-s," as it is mentioned in the following sentence.

P4 Response (SC-17)*: Agreed. This change has been made in the revised report.*

18. Section 4.2.6; Page 4-14; Paragraph 1

If it was "not possible to segregate riparian vegetation results by plant species," how were preliminary COC concentrations in culturally significant riparian vegetation measured? Discuss.

P4 Response (SC-18)*: As discussed in Section 4.2.6, riparian vegetation was sampled and analyzed for a suite of five constituents of concern (i.e., cadmium, copper, molybdenum, selenium, and zinc). The BRA in Appendix A, Sections 3.3.2.1 and 3.3.2.2 states that measured riparian vegetation data were used in the risk assessment calculations for aquatic culturally significant plants, where available. When plant tissue data were unavailable (i.e., not one the five COCs listed above), the plant tissue concentrations of individual constituents (e.g., vanadium) were modeled based on uptake from soil and sediment.*

19. Section 4.3.4.1; Page 4-20; Paragraph 4; Sentence 4

The sentence says, "While these concentrations [for sediment] are notable, they have little relevance to the Site as they are not associated with the Site nor were they considered background." Yet, two paragraphs previous for riparian soil, "Because these stations were identified as being associated with the Site and not background locations, they were included in the risk calculations for the Site (see Section 6.0)." Explain this seeming discrepancy.

P4 Response (SC-19)*: As discussed under "Other Stations" in Section 4.3.4.1, "These stations, MST058, MST226 and MST275, were assigned as Site surface water stations, because they are* *located on tributaries of the Lone Pine Creek drainage, for which, the Henry Site is the dominant feature in the watershed (Drawing 4-8)." They also provide data for conditions in the entirety of Lone Pine Creek including its headwaters (east and west drainages). As a result, these locations were used in the BRA. The sentence initially referred to in this comment has been removed.*

20. Section 4.4, Page 4-3, Paragraph 1, Sentence 1

This sentence states that "selenium is the most common contaminant detected at the site." Tables A2-1 through A2-7 show that selenium in not the most common contaminant detected in any medium. The sentence should be revised.

P4 Response (SC-20)*: Note that this sentence is on Page 4-23. It has been revised as follows: "Selenium is the most common contaminant detected above its individual surface water screening criteria."*

21. Section 4.4, Page 4-3, Paragraph, Sentence 2

This sentence is not accurate as EPA released new federal water quality criteria for selenium in June 2016 that no longer supports the previous 0.005 milligram per Liter (mg/L) chronic criterion. The current federal water quality criteria (WQC) document recommends water-based lentic and lotic values of 1.5 and 3.1 micrograms per Liter (µg/L), respectively, along with tissue-based. Revisions to the text are necessary to acknowledge the updated federal criteria for selenium.

P4 Response (SC-21)*: See response to GC-D. The document has been revised to reference the updated criteria for selenium.*

22. Section 4.4.1; Page 4-23; Preliminary Contaminants of Concern…, last paragraph and page 4-24 first paragraph and elsewhere in the document

Delete the word "slightly" where it describes sampling from the sentences where exceedances are spoken about (and elsewhere in the document) as this term is subjective. A constituent either exceeds or does not exceed screening criteria. Modify as necessary to describe the magnitude of exceedance.

P4 Response (SC-22)*: The word "slightly" has been globally searched and replaced or qualified with an order of magnitude of percentage unit of measure throughout the revised report.*

23. Section 4.4.2; Page 4-26; Paragraph 2; Sentence 5

Change: "This pond is typically dry in the fall (Figure 4-7)," to "This pond is typically dry in the fall (note the absence of sampling data in the fall on Figure 4-7)."

P4 Response (SC-23)*: Agreed. This change has been made in the revised report.*

24. Section 4.4.3; Page 4-27; Paragraph 3 (last); Sentence 3

Delete "slightly" (too subjective, especially when concentrations are two and three times the criterion) and change to "exceed" (for subject-verb agreement) to read "… MDS016 (0.018 mg/L) exceeds the screening criteria, and two of three samples from MSG002 (0.012 and 0.016 mg/L) exceed the screening criteria."

P4 Response (SC-24)*: Agreed. The word "slightly" has been replaced in the revised report as noted in the response to SC-22.*

25. Section 4.4.3; Page 4-28; Paragraph 2; Sentence 1

Only one of six concentrations in Table 4-10 for arsenic were reported at the method detection limit (MDL). Revise.

***P4 Response (SC-25)**: Agreed. Section 4.4.3, Page 4-28, Paragraph 2 has been revised as follows: "The measured concentrations of cadmium (key preliminary COC/COEC) in the seeps and spring are typically reported at the MDL (e.g., <0.0001 mg/L) as shown in Table 4-10 with a maximum cadmium concentration of 0.0008 mg/L in MDS016 (spring 2006). Arsenic concentrations ranged from <0.0005 mg/L in MDS022 (spring 2006) to 0.0079 mg/L in MDS034 (spring 2008). These cadmium and arsenic concentrations are below their screening criteria."*

26. Section 4.4.3; Page 4-28; Paragraph 2; Sentence 2

Based on Table 4-10, it looks like the maximum arsenic concentration should be 0.0079 mg/L in MDS034 in Spring 2008. Revise.

***P4 Response (SC-26)**: Agreed. This maximum arsenic concentration has been changed in the revised report. See response to SC-25.*

27. Section 4.4.4.1, Page 4-28, last paragraph, Sentence 3

Dilution is one of several processes for which attenuation may occur. Revise the sentence to read "… through attenuation (e.g, dilution)."

***P4 Response (SC-27)**: Section 4.4.4.1, Page 4-28, last paragraph, Sentence 3, has been revised to read "…. through attenuation (e.g., dilution, sorption, or redox reactions)."*

28. Section 4.4.4.1; Page 4-30; Bullet 3

Shouldn't the value 0.0011 mg/L be included in the MST276 box on Drawing 4-10 where the three samples shown were all nondetects? Revise accordingly.

***P4 Response (SC-28)**: The concentration of 0.0011 mg/L at MST276 was based on a total concentration. For surface water, dissolved concentrations were used for comparison to screening criteria and to develop the summary statistics reported on Drawings 4-9 and 4-10. The exception to this is selenium, where the standard and data are based on total concentration. This will be indicated on Drawings 4-9 and 4-10 and noted in the text. The bullets on Page 4-30, Section 4.4.4.1 have been revised to indicate dissolved or total concentrations.*

29. Section 4.4.4.1; Page 4-31; Paragraph 2; Line 1

According to the MST275 box in Drawing 4-10, the minimum should be less than 0.001 mg/L. Revise accordingly.

***P4 Response (SC-29)**: The text is correct. As shown in Appendix B Table B-6b, the lowest detection limit for total selenium at MST275 is 0.0005 mg/L. The minimum value in Drawing 4-10 was incorrectly rounded and has been changed on the drawing in the revised report to 0.0005 mg/L.*

30. Section 4.4.4.1; Page 4-31; Paragraph 2; Line 3

According to the MST275 box in Drawing 4-10 the minimum should be 0.0005 mg/L. Revise accordingly.

***P4 Response (SC-30)**: This change has been made in the revised report.*

31. Section 4.4.4.2; Page 4-32; Little Blackfoot River

Figures 4-10 and 4-11 do not show sampling results for 2011. Was sampling performed in 2011? If so, please include this information. If not, please include a comment as to why sampling was not performed.

***P4 Response (SC-31)**: Sampling was not performed in 2011. A note has been added to Figures 4-10 and 4-11 in the revised report.*

32. Section 4.4.4.2; Page 4-32; Little Blackfoot River

There appears to be a data gap in surface water sampling locations along the Little Blackfoot River, between MST044 to the confluence with Long Valley Creek/Long Valley Creek Tributary.

***P4 Response (SC-32)**: See the response to SC-15.*

33. Section 4.5.2; Page 4-36; Hydrostratigraphy Units

Describe the sampling results of the Monsanto agricultural wells (MAWs) and Monsanto Domestic Wells (MDWs).

***P4 Response (SC-33)**: A summary of the historical ground water COC sampling results has been included in new table in Section 4.5 in the revised draft.*

34. Section 4.5.2; Page 4-36; Paragraph 6 (last); Sentence 1

Where are total dissolved solids (TDS) concentrations shown on Drawing 4-11? Revise accordingly.

***P4 Response (SC-34)**: Reference to TDS has been removed from the sentence.*

35. Section 4.5.2.1; Page 4-38; Shallow Alluvial Unit

a. Does the water in the alluvial aquifer flow downward to lower bedrock units? If alluvial groundwater is or becomes impacted and flows into deeper aquifers, the CSM needs to reflect this possibility. Evaluate vertical groundwater gradients.

b. Text states, "Surface water flow is *presumed* to be directed westward. (1) Should this be "*Groundwater* flow …." (2) Part of site characterization and developing the CSM is to identify the groundwater flow direction; not *presume* where it is directed.

c. From the western mouth of the canyon, the LBFR flows to its confluence with Long Valley Creek and then northwest toward the Blackfoot Reservoir; the site geology map (Drawing 2-2) indicates a ribbon of alluvium. However, no direct push borings or alluvial wells are located along this corridor (Drawing 3-3; 4-11). This is the direction of surface water flow, downgradient of the mine site, and likely shallow groundwater flow in the alluvium, based on the topography. Does shallow groundwater data exist for this area or does this represent a potential data gap?

***P4 Response (SC-35)**:*

a. Vertical gradients were not extensively evaluated during the RI or in this <u>Henry RI Report</u> because of the general lack of alluvial groundwater concentrations exceeding the regulatory screening levels (refer to Drawing 4-11). The most notable exception is the monitoring well MMW010 location. The nearest bedrock well is MPW023 located approximately 750 feet to the southeast in Phosphoria Formation, and COC concentrations do not exceed screening levels in this well. This suggests that downward migration into the bedrock at this location is not occurring despite an apparent slight downward gradient indicated by comparisons of MMW010 and MPW023 water level measurements. Both wells are installed in mining disturbed areas, and adjacent to a backfilled mine pit. This discussion has been added to Section 4.5.2.1 in the MMW010 presentation.

b. Fundamental to the discussion of flow in the alluvial (including colluvium) system is the recognition that these deposits form a thin veneer of clay, sand and gravel deposited over the bedrock. Where encountered, groundwater is typically between 0 and 20 feet below the ground surface. The relief on the hillsides is on the order of 100's of feet, so in most cases, the water table mirrors the topography. The exception at the Site is along the Little Blackfoot River and *upper reaches of Lone Pine Creek that may locally be underlain by thicker alluvium. However, in the upland areas it is the topography and drainage locations that dictate the direction of shallow groundwater flow, which is similar to surface water flow. The sentence in question was rewritten as follows – "Groundwater flow locally, in the thin alluvial deposits, is directed westward toward the Little Blackfoot River following the topography and the local drainage, and roughly parallels the alignment of the three boreholes in this area."*

c. *Because of the general absence of COC concentrations in surface water or groundwater exceeding groundwater screening levels, downgradient investigation of alluvial groundwater near the confluence of Long Valley Creek was not conducted. This area is approximately 4,000 feet downstream of the Site, and is not considered a data gap. Please see response SC-15 regarding additional surface water investigation in this same area.*

36. Section 4.5.2.1; Page 4-40; Shallow Alluvial Unit

Explain the cadmium results in MMW004 and other wells. Describe the less-than-0.1 (non)detect (above MCL, but below detection limit) (see Drawing 4-11).

***P4 Response (SC-36)**: Cadmium is discussed where it exceeds its screening criteria (i.e., its MCL) which is limited to monitor well MMW010. A single sampling event in October 2005 resulted in a cadmium method detection limit (MDL) above the MCL that affected samples from two wells (MMW004 and MPW022). These wells have several other non-detect results at an MDL below the screening level. This isolated occurrence of a higher MDL does not warrant additional discussion in the text, although, a footnote has been added to the text in this location.*

37. Section 4.5.2.1; Page 4-41; Shallow Alluvial Unit

Text states that alluvium was investigated using "….two monitoring wells." Explain how flow direction is calculated from only two monitoring wells.

***P4 Response (SC-37)**: We are unclear as to where on page 4-41 the comment is referencing. The discussion on page 4-41 primarily addresses analytical results from MMW004 and MMW019.*

Both of these wells lie between waste rock dumps and the Little Blackfoot River, and the purpose of these wells is to sample and analyze the groundwater next to the source areas for contamination. As discussed in response SC-35, it is a reasonable assumption in the alluvial system that groundwater flows from the recharge areas on the hillsides toward topographic low points, in this case the LBFR. That places both wells downgradient of major waste rock deposits (i.e., source areas), which was the objective of the investigation. These wells are on either side of the river, and they are not directly related. In addition, as stated in Section 4.5.2.1, the northern alluvial area was investigated by 14 direct-push boreholes including one that became borehole well MBW152, as well as MMW019 and MMW004. These wells and borings were used to evaluate groundwater flow directions. No revisions to the text are recommended.

38. Section 4.5.2.1; Page 4-42; Shallow Alluvial Unit; Paragraph 5 (last); Line 6

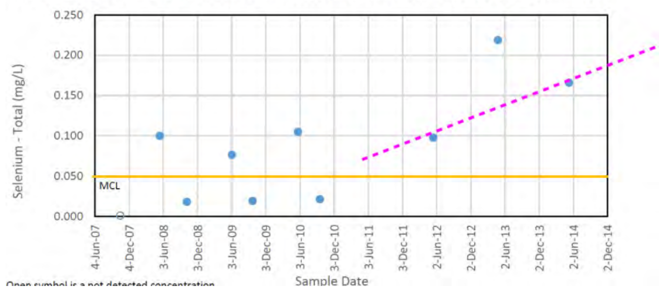
Text states, "This drainage was investigated with three boreholes (BH072, BH076, and BH079)." Should 076 be 078? Revise accordingly.

***P4 Response (SC-38)**: The text has been corrected to "(BH072, BH078, and BH079)".*

39. Section 4.5.2.1; Page 4-43; Shallow Alluvial Unit, Figure 4-15

Text states "Selenium concentrations in MMW010 exceed the criteria of 0.05 every spring…and all fall results are below 0.05 mg/L." According to Figure 4-15, no fall samples are available after 2010, and since 2011 the springtime samples have increased and are as high as 0.219 mg/L. Fall samples could very well be above the MCL by now. Either provide fall samples, or modify statement to say that no fall samples have been collected since 2010, and the 2013 and 2014 samples are historic highs.

FIGURE 4-15
TIME SERIES SELENIUM CONCENTRATIONS FOR MONITORING WELL MMW010



__P4 Response (SC-39)__: The sentence has been revised to say, "Selenium concentrations in MMW010 exceed the criteria of 0.05 mg/L every spring with concentrations up to 0.219 mg/L, and all the fall results were below 0.05 mg/L when they measured prior to 2011 (__Figure 4-15__)." P4 does not intend on adding 2015 concentrations to the <u>Henry RI Report</u> (these are reported in the associated 2015 DSR). However, the spring 2015 total selenium concentration in MM010 was 0.119 mg/L (more in line with the pre-2013 concentrations).

40. Section 4.5.2.2; Page 4-45; Dinwoody Formation

a. Text states "Constituents from the Site could migrate northeastward perpendicular to the syncline axis toward the Henry Thrust Fault, or parallel to the axis of the syncline toward the northwest." The goal of a site characterization/RI is to determine with confidence which way the water flows and thus evaluate where the COCs may migrate – please provide rationale for this statement, or additional discussion.

b. Text states that two monitoring wells were installed to evaluate these flow paths – two monitoring wells do not appear to be adequate to enable characterizing the flow direction and gradient in the Dinwoody formation. Please clarify and resolve.

***P4 Response (SC-40)**:*

a) In the case of the Dinwoody Formation, COCs detected in groundwater contained therein do not exceed their respective screening levels near the source of contamination (where they should be the highest). Therefore, the need for further investigation was dismissed for reasons presented below.

Groundwater collected from monitoring well, MMW022, (installed through the edge of the waste rock dump and into the Dinwoody Formation aquifer), does not exceed screening levels for COCs, and therefore, indicates there is no plume to be evaluated in the area. At the time of the RI groundwater investigation, the concentrations in MMW022 were approximately 0.020 mg/L selenium, below the selenium MCL of 0.050 mg/L. This initially warranted addition investigation, because it indicated a completed flow path (but again not above the selenium or other COC MCLs).

Additional investigation included two activities: 1) installation of a new monitoring well (MMW028) to the northwest along the Dinwoody bedding strike. This location evaluates the most critical pathway because Dinwoody groundwater is moving towards the LBFR, and 2) a survey for springs/seeps in the area to the northeast of MMW022, toward the Henry Thrust

Fault. Installation of a monitoring well northeast of MMW022 was not considered necessary because this pathway:

- *Is not as critical for any human/ecological receptors,*
- *Was being investigated indirectly by surveying for seeps/springs,*
- *And any possible locations for a monitoring well along this pathway likely would be on other private property, and construction of an access road would be necessary and difficult in any of the suitable locations to the northeast.*

Groundwater results from samples collected from MMW028 (ranging from 0.00264 – 0.0115 mg/L selenium) indicate that the flow path toward the LBFR is complete, but none of the COCs are detected at levels exceeding groundwater standards (MCLs) along this migration pathway. The spring/seep investigation on the hillside to the northeast of MMW022 indicated no spring discharges. Given the geologic (bedding) configuration of the area, if groundwater flow is northeastward, springs could be expected. The absence of springs suggests the predominant flow direction is not northeastward and toward the Henry Thrust Fault. Since the time of these additional investigations, long term monitoring results of MMW022 indicate that the selenium concentrations have increased, but they do not exceed the selenium MCL. Please refer to SC-49 for additional information on the history of investigation activities related to groundwater contained in the Dinwoody Formation.

The field investigations discussed above (i.e., at and around MMW022) and LTM data have shown us that compared to most areas at the Henry Mine, the area around MMW022 has the potential for producing concentrations that exceed the selenium MCL. The reasons for this are that the physical configuration of the reclaimed area is conducive for higher infiltration through a relatively thin layer of waste rock (thinner waste rock deposits appear to leach more selenium due primarily to less attenuation within the waste rock deposit [Hay, et. al., 2016]). These physical factors will need to be considered when evaluating alternatives for remediation the Site's upland soils/waste rock during the FS.

b) Regarding the movement of groundwater in the Dinwoody Formation, please refer to comment response SC-8. The issue related to groundwater movement (hydrogeology) in the Dinwoody Formation are similar to the Wells Formation in that groundwater movement tends to be structurally and lithologically controlled in these two formations at the Site. The most probable flow path in the Dinwoody Formation is toward the LBFR (a low point) along the strike of bedding. However, it is acknowledged that flow to the northeast across structure toward the Henry Thrust Fault cannot be ruled out, and therefore may be a possibility. Because there is no plume exceeding screening levels in the area, the uncertainty should be acceptable. However, the LTM groundwater results do point to the need for a reduction of precipitation infiltration into the closed basin created by the waste rock in the MMW022 area. Future source controls selected during the FS in this location might include increasing the thickness of the ET cover or regrading and diverting stormwater away from the area, etc., which would reduce the potential for further contamination of the underlying Dinwoody Formation groundwater.

Given the discussions above, there is more certainty than indicated in this <u>Henry RI Report</u> in regard to the northwest flow direction. Therefore, the second sentence of the introductory paragraph of Section 4.5.2.2 has been revised to say:

> *"This location is in the recharge zone for the Dinwoody Formation; constituents from the Site are migrating parallel along the axis of the syncline toward the northwest and the Little Blackfoot River. However, some migration to the northeast toward the Henry Thrust Fault, perpendicular to the syncline axis also is possible (refer to Section 2.6 for further hydrogeology discussion)."*

As discussed above, the basis for this statement is the CSM and the results from MMW028 that indicate some COC migration to that location.

41. Section 4.5.2.2; Page 4-45; Dinwoody Formation

Regarding the elevated selenium concentrations in MMW022 after the "large recharge event of 2011" and that the elevated concentrations are an advancing pulse from an "uncommon" recharge event, as opposed to an advancing plume - following text states that concentrations should decrease in future sampling rounds "*assuming additional anomalous recharge events do not occur."* It cannot be predicted if, and when, another uncommon or anomalous recharge event will occur. This reasoning appears flawed; please revise.

***P4 Response (SC-41)**: Agreed. There will be future high recharge events, and the discussion does not reflect the issue correctly. The issue is not whether a high recharge event will occur in the future (they will), but if there are consecutive events, which might not allow the pulse from an individual event to dissipate. The sentence has been revised to say, "Therefore, the elevated concentrations appear to be related to the uncommon recharge event (an advancing pulse) as opposed to an advancing plume. If the former is the case, then concentrations should decrease in future sampling rounds as the pulse migrates and dissipates and/or attenuates as it moves downgradient (i.e., assuming consecutive or closely spaced anomalously high recharge events do not occur)."*

42. Section 4.5.2.3; Page 4-46; Wells Formation

Text states "flow direction in the Wells Formation at the site is *predicted* to be to the northwest toward the springs…" See previous comment (#35) – the flow direction in the Wells Formation aquifer is important for determination of the fate and transport of COCs. Typically, flow direction in the area is more to west; flow direction should be confirmed by site data. Please clarify and resolve.

***P4 Response (SC-42)**: Please see the response to SC-8.*

43. Section 4.5.2.3; Page 4-48; Paragraph 1; Sentence 2

If all but one selenium concentration was a non-detect, then all but one concentration represented in Figures 4-19 and 4-20 should be open symbols. Revise accordingly.

***P4 Response (SC-43)**: The sentence is incorrect. The concentrations on Figures 4-19 and 4-20 are correct, and the sentence has been revised as follows: "With one exception (i.e., concentration of 0.017 mg/L in MMW023), selenium concentrations in both monitoring wells are below 0.004 mg/L."*

44. Section 4.5.2.4; Page 4-49; Other Hydrostratigraphic Units

Text describes how the wells are likely downgradient of the mine pit and upgradient of the Lone Pine creek. Provide more data to substantiate this assertion. Show this on the cross section to illustrate the argument.

***P4 Response (SC-44)**: Well MPW022 has been projected into Drawing 5-3 showing the relationship between this well and the Lone Pine Creek alluvial system. Conditions at MPW023 are similar, but with slightly flatter gradients. A reference to Drawing 5-3 has been added to the text.*

45. Section 4.5.3; Page 4-51; Water Quality Typing

Text states "were [sic] oxidizing sulfides are a source of selenium." (a) Change "were" to "where" and (b) Are the oxidizing sulfides the actual source of selenium, or do they merely increase the mobility? This statement is not clear – the middle waste shale is typically identified as the source of selenium. Please clarify the statement.

> ***P4 Response (SC-45)**: a) The typo was corrected. b) The sentence in question read, "This is consistent with the conceptual geochemical model, discussed in detail in the <u>RI/FS Work Plan</u>, were oxidizing sulfides are a source of selenium". To address the comment, the sentence has been revised to say, "<u>This is consistent with the conceptual geochemical model, discussed in detail in the RI/FS Work Plan, where oxidizing sulfides in the waste shales are a source of selenium</u>". (The center waste shale [CWS] is a major source of selenium, but other beds in the Meade Peak Member may also contribute.)*
>
> *However, please note that in context, the statement questioned is explaining the relationship between sulfate and selenium. The geochemical reservoirs of selenium include, readily soluble selenium compounds, sulfides, and some organically bound selenium. In the Idaho phosphate mines, the soluble selenium compounds typically are identified as the dominant source of selenium to the environment. However, most of this soluble selenium is chemically associated with sulfide weathering (oxidation) that occurred in situ prior to mining. It has been shown that sulfides are the main reservoir of selenium in <u>unweathered</u> CWS (Perkins and Foster, 2004). The sulfides also are the source of sulfate upon oxidation. Weathering has occurred over geologic time to produce the soluble selenium and sulfate minerals that may be dissolved and be released upon mining. Some amount of oxidation also may occur post-mining depending on specific conditions. Regardless of when the oxidation occurred, because of the chemical relationship, the selenium-sulfate correlation has remained.*
>
> *In regard to the portion of the comment related to increased mobility, because of the inherent net neutralization potential of the Phosphoria Formation rocks, pervasive acidic conditions do not develop. Therefore, sulfide oxidation can lead to release of selenium bound in sulfides more so than acid leaching of other minerals and organics that contain selenium.*

46. Section 4.5.5; Page 4-53; Aquifer Solids

Text states, "*It is possible* that at this location the alluvium was derived largely from the Meade Peak Member outcrop." Please review drilling logs to evaluate whether information is available to address this question of interest. It should be obvious if the alluvium is derived from the Meade Peak formation. For future characterization activities, the onsite geologist should carefully log the borings and evaluate the provenance of the alluvium to accurately characterize the site. During future investigations, please provide detailed logging and observations of drill cuttings and lithologic samples.

> ***P4 Response (SC-46)**: It is incorrect to assume that, "it should be obvious if the alluvium is derived from the Meade Peak Formation". The alluvium is dominated by brown clays, silt and sand with some gravel (<u>RI/FS Work Plan, see direct push and well logs)</u>. Based on the lithological composition of the geologic units at the Site, the clay and silt largely originates from the Phosphoria, including the Meade Peak Member, or Dinwoody Formations, and much of the sand is likely from the Wells Formation. However, the Meade Peak Member clay does not retain its dark color upon weathering and is not likely visually distinguishable from clays derived from the Dinwoody Formation or Cherty Shale Member (Phosphoria Formation) as an example. No study has been conducted to confirm this, but it is based on field observations including during drilling. Weathered Meade Peak Member rock locally is called brown shale, and it is the source of the Henry Mine cover material. The best way to*

distinguish the origin of these different clay types is geochemically, because visual confirmation is not possible. Identification of larger rock fragments in the colluvial soils could help identify the source of the material, but the origin of the clays and large rock fragments may be from separate sources.

All borings were logged by an on-site geologist/hydrogeologist, and the logs are provided in the RI/FS Work Plan or in subsequent RI Data Summary Reports (DSRs). Because the logs have been submitted to the A/Ts, we are not resubmitting these data at this time. However, the RI/FS WP and other DSRs should be available to this reviewer, and if not, can be provided electronically.

47. Section 5.1.4; Page 5-7; Groundwater Pathways

Text states "This resulted in validation of potential pathways and identification of those pathways requiring further investigating." Has further investigation been conducted, and if so, what are the results?

P4 Response (SC-47)*: The sentence in question is contained in a paragraph describing the overall approach to the groundwater investigation. Further investigation was conducted as part of the RI process, and these data are reported in this Henry RI Report. For example, there were two rounds of direct-push investigation. The second round was conducted to address data gaps identified following the conclusion of the first round. Monitoring well MMW028 was installed in response to the results from MMW022. The sentence has been modified to say, "This resulted in validation of potential pathways and identification of those pathways requiring further investigation during the RI."*

48. Section 5.1.4; Page 5-7; Groundwater Pathways

Text states, "Deeper groundwater flows generally along bedrock bedding is either to the northwest or southeast." This statement is confusing as written and suggests a lack of site knowledge. Revise.

P4 Response (SC-48)*: The sentence highlighted is contained in an introductory paragraph and is followed by "The details of the groundwater contaminant transport pathways for each of the flow systems are presented in the following subsections." Therefore, the uncertainty is addressed in the following sections. However, the conclusion is that evidence indicates that bedrock groundwater flow is dominantly to the northwest, and the sentence has been revised as follows: "Deeper groundwater flows generally along bedrock bedding, primarily to the northwest toward the Henry Springs discharge area."*

49. Section 5.1.4.2; Page 5-9; Dinwoody Formation

This section describes flowpaths from waste dumps into the Dinwoody and general groundwater flow in the Dinwoody Formation. Text states "Contaminated external waste rock dump seepage entering the Dinwoody Formation…..forms complete flow paths." In nearby sites, elevated COCs in the Dinwoody Formation are observed where waste rock dumps directly overlie this unit (for example, elevated COCs are found where MWD086 overlies the Dinwoody and MMW022). Another example where this could occur at the Henry Mine is where MMW085 overlies the Dinwoody Formation (Drawings 2-2 and 5-2 [Section P-P']. No monitoring well is installed to monitor this portion of the Dinwoody Formation (Trd) and is considered a data gap**.** See General Comment B for direction.

P4 Response (SC-49)*: As presented in the RI/FS Work Plan, the approach was not to investigate every location of possible COC impacts over the large area represented by the Site. The RI objective was to investigate various locations with specific conceptual flowpath configurations that appeared to have the highest probabilities of COC impacts to Site groundwater. In the case of the Dinwoody Formation, the MMW022 location was investigated, and based on field observations and groundwater results from that installation, MMW028 was installed. The MWD085 and MWD086* *locations were not considered a large concern as drainage and slopes were more favorable for reducing infiltration.*

The MMW022 location was selected because there is a large area of waste rock overlying the Dinwoody Formation in this area, and the reclamation grading forms a localized closed basin (i.e., surface water must infiltrate because there is no outlet for runoff). Additionally this location is on the possible flow path along the Dinwoody Formation strike, which is towards the LBFR. MMW028 was installed further to the northwest (again along strike) the next year, after elevated concentrations of selenium were detected in MMW022, to address the most critical possible flow path along strike towards the LBFR (refer to Drawing 2-2 for the locations of these wells).

Based on the conceptual Site model and flow path associated with MMW022, no further investigation of the "waste rock – Dinwoody on-lap" was conducted. This was largely because the MMW022 location represents a "worst case" position along the flowpath, but has not exceeded COC screening levels (the sulfate screening level has been exceeded, but it is not a COC).

One point of further clarification needs to be made. These Dinwoody monitoring wells (i.e., MMW022 and 028) were installed and sampled prior to development of the RI/FS Work Plan. The groundwater results from these wells were considered in scoping the RI/FS Work Plan and the A/T concurred with the Dinwoody Formation investigation approach that included no additional Dinwoody Formation monitoring wells (i.e., it was determined that there was not a data gap).

50. Section 5.1.4.3, Page 5-9; Wells Formation Groundwater System

As noted, the Wells Formation is considered a host of regional and/or intermediate groundwater systems. The report provides a compelling argument that the Wells Formation groundwater is fault-controlled and that, "these Faults appear affecting and focusing regionals groundwater transport and discharge" and that "This flow direction is supported by site data, specifically the piezometric levels in monitoring wells MMW011 and MMW023."

a. The wells Formation is interrupted by folding and faulting throughout the region. However, regional data indicate that despite the structural controls, the Wells Formation aquifer exhibits a relatively uniform groundwater elevation and gradient, with flow generally to the west. Two monitoring wells located in the northern part of the site do not necessarily provide the required data to evaluate site-wide flow directions and gradients. This is a potential data gap. Please include regional data from other mine sites (e.g. data from 2010 Technical Memorandum – Groundwater Flow in the Wells Formation), or other wells constructed in the Wells Formation to enhance the discussion and support assertions (in addition to the two observed piezometric levels on site). See General Comment B for direction.

b. No monitoring wells have been constructed south of the LBFR so, despite open and backfilled mine pits and large areas of Wells Formation outcrop, the entire southern two-thirds of the site has no groundwater data for Wells Formation. For example, Drawing 5-3 (Cross Section N-N') shows an idealized scenario where a backfilled/open mine pit with a pond (MSP055, which contains elevated cadmium, nickel, selenium, and zinc that exceed surface water and groundwater screening levels) could recharge directly into the Wells Formation and introduce COCs. This is considered a data gap. See previous comment, and also General Comment B for direction.

***P4 Response (SC-50)**:*

a) Please see the response to Comment 8 (SC-8). Data from mines miles away do not provide any insight into groundwater flow at the Site.

b) Several discussion points should be considered in response to this question. First, pond MSP055 is a seasonal pond located on the mine pit floor, which primarily overlies the Meade Peak Member (CWS, etc.). However, it does abut the Wells Formation-Meade Peak Member contact. Second, the water table was quite high in this area of the mine as indicated by P4's installation of dewatering wells MPW022 and MPW023. The elevated water table in this area further supports the northwest flow component at the Site, making MMW011 downgradient. Third, the flow path is contained within the Site and is monitored by two downgradient monitoring wells – MMW011 and MW023.

P4 does not agree that there is a data gap as Wells Formation groundwater flow in this area is restricted to the northwest and into the core of the Site as discussed in Response SC-8. Because of surface water risks, MSP055 will be addressed in the FS. Remedial action (RA) solutions for this location should be relatively straightforward (e.g., lined surface water collection and retention systems; backfill, grading and applied cover system over portions of the pond area; and/or run on/run off controls), and the RA construction work can address both the surface water and possible groundwater issues based on the FS evaluations.

51. Section 5.1.4.4; Page 5-11; Structural Flow System

The second paragraph describes a potential east-west trending structure located between MMP-041 and MMP043, and the third paragraph describe other smaller faults in the site vicinity. The report concludes that these potential structures would not likely affect groundwater flow. The reviewer would like to acknowledge that he appreciates the extra effort put into the site investigation to look further than existing data points to identify previously unknown structures and evaluate their potential to influence COC fate and transport. Nice job.

***P4 Response (SC-51)**: Thank you. As noted in SC-8, groundwater flow in the Wells Formation is strongly influenced by the location and orientation of the Wells Formation (i.e., the local geology including the structural geology component), in particular, the sandstone beds in the upper portion of the unit. Any disruption in the continuity of the unit would be significant for the CSM, and therefore, had to be evaluated.*

52. Section 5.3.3; Page 5-18; Surface Water

The text states that COCs do not make it to LBFR via Lone Pine Creek and that the most downstream affected station is MST057. Suggest adding that MST056 is non-detect and therefore delineates the downstream extent of COCs in Lone Pine Creek.

***P4 Response (SC-52)**: Agreed. The text has been revised to state that concentrations of all COC/COECs are below surface water screening criteria at MST056, which therefore delineates the downstream extent of elevated COCs/COECs in Lone Pine Creek.*

53. Section 5.3.3, Page 5-18, Paragraph 2, Sentence 3

Dilution is one of several processes through which attenuation may occur. Revise the sentence to read "Through attenuation (e.g, dilution)…"

The second part of this sentence "…concentrations of contaminants…" should be revised to read "…<u>elevated</u> concentrations of contaminants…"

***P4 Response (SC-53)**: Agreed. The first part of the sentence has been revised to read "…. through attenuation (e.g., dilution, sorption, or redox reactions)". The second part has been revised as suggested.*

54. Section 5.3.4; Page 5-20; Groundwater

The text states "The southeast portion of waste rock dump MWD085 is adjacent to and overlies the basalt (Drawing 2-2). Therefore seepage or infiltration from MWD085 may recharge and could cause impacts to groundwater within the basalt." Based on Drawings 2-2 and 5-2 (Cross Section P-P'), MWD085 overlies the Dinwoody and upper Meade Peak (Rex Chert/Cherty Shale) formations, but does not directly overlie basalt. Please revisit and revise this discussion to be more accurate. In addition, no data are available to evaluate the potential impacts to the Dinwoody Formation beneath MWD085; and is thus considered a data gap. See General Comment B for direction.

> ***P4 Response (SC-54)****: The comment is correct; the waste rock is not mapped as directly overlaying the basalt. However, a flow path still exists via the alluvium that tends to pinch out on the basalt. The sentence in question has been revised to say, "The southeast portion of waste rock dump MWD085 is adjacent to the basalt (Drawing 2-2). Therefore, seepage or infiltration from MWD085 into the alluvium could flow downhill, infiltrate the basalt and could cause impacts to groundwater within the basalt."*
>
> *Based on the Dinwoody investigation adjacent to MWD086 and MWD088 (MMW022 and MMW028), it was determined that investigation of Dinwoody Formation below MWD085 was not necessary. P4 does not consider this a data gap. See response SC-49 for additional discussion.*

55. Section 5.3.4.1, Page 5-23; Alluvial System

Text states "Groundwater samples collected further downgradient at BH169 (0.016 mg/L)…" Double-check this value; it should be 0.0016 mg/L.

> ***P4 Response (SC-55)****: This value has been corrected in the revised Henry RI Report text (as provided in your comment – 0.0016 mg/L).*

56. Section 5.3.4.2; Page 5-24; Dinwoody Formation

The text describes:

- the interaction between waste rock dumps and the Dinwoody Formation, where the lack of alluvial material allows direct infiltration into the Trd;
- how MMW022 was installed as a "worst case" scenario to evaluate COC loading in the Trd; and
- how MMW022 shows elevated COCs (near the MCL for selenium) that are related to the large recharge of 2011.

This discussion reinforces the need for a monitoring well in the Dinwoody underneath MWD085, which is in direct contact with the Dinwoody (outcrops of Dinwoody are clearly evident adjacent to this waste rock pile). This appears to be an idealized situation to contribute elevated COCs into the Dinwoody and reduce its potential as a beneficial use aquifer. See also Specific Comment 55.

> ***P4 Response (SC-56)****: Please see responses to SC-49 and SC-54.*

57. Section 5.3.4.3; Page 5-26; Wells Formation

The text attributes low concentrations of COCs in the Wells Formation to a lack of selenium mobility in reducing conditions and reducing flowpaths, among other reasons. However, no monitoring well is constructed in the Wells Formation beneath pond MSP055, which contains some of the highest COC concentrations at the site and sits directly on Wells Formation exposed in the mine's footwall. Clarify how this determination was made.

> ***P4 Response (SC-57)****: See response to SC-50.*

58. Section 5.3.4.4; Page 5-26; Migration Summary in Site Groundwater Systems

The text states, with respect to the Dinwoody Formation, that "concentrations in the unit increase with increased winter precipitation and snowmelt. However, to date screening criteria have not been exceeded in this unit." Note that in MMW022, the average sulfate concentration exceeds the screening level, and selenium is very close to the MCL. It is possible that future large precipitation events could push the selenium level higher. Revisit and revise narrative.

> ***P4 Response (SC-58)**: The text has been revised to be consistent with response SC-41. The bullet now reads, "The conceptual model of contaminant transport into the Dinwoody Formation groundwater on the northeastern edge of the Site appears to be validated, and concentrations in the unit increase with increased winter precipitation and snowmelt. However, to date screening criteria have not been exceeded in the unit with the exception of sulfate, which is not a COC based on its screening criteria (i.e., secondary MCL) not being an ARAR. It is possible that future selenium concentrations could exceed screening levels as the result of sequential or closely spaced above average precipitation years."*

59. Section 6.1, Page 6-3, Paragraph 2, Sentence 3

Remove the two occurrences of "incremental" from the sentence. Using "incremental ILCR" is duplicative since ILCR is an acronym for incremental lifetime cancer risk.

> ***P4 Response (SC-59)**: Please note that the "I" for incremental in "ILCR" indicates that the cancer risk presented is the increase in cancer risk above the incidence of cancer in the general population (about one in three). In contrast, the "incremental" in "incremental ILCR," as defined in the first sentence of the referenced paragraph, refers to the increase in cancer risk associated with historic activities at the Site above the cancer risk associated with constituents present at regional background or ambient concentrations.*
>
> *The first two sentences of the referenced paragraph state: "The Tier II HHRA also includes the calculation of RME-based incremental risk estimates, defined as the COPC-specific difference between the risk estimates for Site and background sample locations. COPC-specific incremental ILCR and HQ estimates are summed to cumulative incremental ILCRs and HIs for each medium and receptor." As described above, the first sentence defines incremental ILCR estimates and the incremental HQ estimates presented in the BRA for the Henry Site as the ILCR/HQ estimates calculated from concentrations of COPCs measured in media at Henry Site sample locations minus the ILCR/HQ estimates calculated from concentrations of COPCs measured in media at background sample locations. To clarify this point, the first two sentences of the referenced paragraph have been revised as follows: "The Tier II HHRA also includes the calculation of RME-based incremental ~~risk~~ <u>ILCR and HQ</u> estimates, defined as the COPC-specific difference between the ~~risk~~ <u>ILCR and HQ</u> estimates for <u>the</u> Site and <u>the ILCR and HQ estimates for</u> background sample locations. COPC-specific incremental ILCR and <u>incremental</u> HQ estimates are summed to cumulative incremental ILCRs and <u>incremental</u> HIs for each medium and receptor." Additionally, the final sentence of the third paragraph of 6.1, on page 6-2, has been revised as follows: "For each receptor evaluated, incremental lifetime cancer risks (ILCRs)<u>, defined as the incremental increase in cancer risk above the incidence of cancer in the general population,</u> and noncancer hazard quotients (HQs)<u>, defined as the ratio of exposure to a noncarcinogenic constituent and the exposure level for that constituent at which no adverse effects are expected,</u> are calculated for individual chemicals.~~; and~~ <u>Subsequently,</u> cumulative ILCR and cumulative HQs, or hazard indices (HIs), are calculated for all chemicals over all applicable exposure media.*

Section 3.3.4 of Appendix A has also been revised to clarify the definitions of ILCR, HQ, incremental ILCR, and incremental HI.

60. Section 6.4, Page 6-6, bullets.

Revised the introductory sentence for the bullets to say, "… are generally interpreted as follows:" Also, the second and third bullets are confusing as written. The second bullet indicates that exposures above the no observed adverse effect level (NOAEL), but below the lowest observed adverse effect level (LOAEL), may pose an unacceptable risk to individuals; the third bullet indicates exposures above the LOAEL may pose an unacceptable risk without clarifying whether this is for individuals, populations, or both. Add clarifying language to these bullets.

***P4 Response (SC-60)**: "Generally" has been added to the introductory sentence for these bullets, and the third bullet has been revised to indicate that a LOAEL-based HQ greater than 1 indicates that adverse effects may occur to populations of ecological receptors in Section 6.4 the RI, and in Sections 4.2.4 and 5.2.4 of Appendix A. Additionally, "may occur to individual receptors" has been added to the second bullet in Sections 4.2.4 and 5.2.4 of Appendix A.*

61. Section 6.6.2; Page 6-12; Paragraph 5; Sentence 2

Stick to talking about the long-tailed vole and save discussion on the deer mouse for its own section. Revise accordingly.

***P4 Response (SC-61)**: The deer mouse was referenced in the text for the long-tailed vole in order to support elimination of antimony from further evaluation as a risk driver in upland soil/waste rock. However, conclusions regarding risk drivers for individual media are more appropriately described in Section 6.9.4. Therefore, the discussion of ecological hazard associated with antimony in upland soil/waste rock has been moved to Section 6.9.4. Similarly, as indicated in the response to SC-98, the comparison of Henry Site and background hazard estimates for the mink has been moved to the risk summary in Section 6.9.4.*

In Appendix A, the Tier II ecological hazard estimates presented in Section 4.3.2 include the same evaluations of hazard estimates associated with Site media relative to hazard estimates for background media under receptor-specific headings. These discussions have been moved to a new Section 4.3.3.

62. Section 6.6.2; Page 6-13; Paragraph 4; Sentence 2

Stick to talking about the deer mouse and save discussion on the long-tailed vole for its own section. Revise accordingly.

***P4 Response (SC-62)**: Please refer to the response to SC-61.*

Tables

63. Include a table that provides a summary of COC concentrations in monitoring wells.

***P4 Response (SC-63)**: A new table has been referenced in Section 4.5, which provides a summary of COC concentrations in the monitoring wells.*

64. Table 4-5. The highlighting for the seventh note listed should be removed.

***P4 Response (SC-64)**: This change has been made in the revised report.*

65. **Table 4-11.** Describe whether these metals concentrations are for total or filtered analytical results. Considering these are for comparisons with MCLs or state groundwater standards, the appropriate comparison should be with total metals concentrations.

 P4 Response (SC-65)*: The metals concentrations in Table 4-11 are for total analytical results. A note has been added to Table 4-11 indicating that concentrations in the table are for unfiltered (total) groundwater metals results.*

66. **Table 4-14.** There are a number of values listed as 0.000 or 0.0. Revise the table to show the correct significant figures.

 P4 Response (SC-66)*: The table has been revised to show the correct significant figures.*

67. **Table 4-16.** A note should be added that describes what the highlighted values in the table mean.

 P4 Response (SC-67)*: A note has been added that states "highlighted values indicate stations where fish were observed."*

68. **Table 6-16.** EPA released new federal water quality criteria for selenium in June 2016 that no longer supports the previous 0.005 mg/L chronic criterion. The current federal WQC document recommends water-based lentic and lotic values of 1.5 and 3.1 µg/L, respectively, along with tissue-based. Revisions to the table are necessary to acknowledge the updated federal criteria for selenium.

 P4 Response (SC-68)*: See response to GC-D.*

69. **Table 6-16.** This table indicates that site-wide surface water exposure point concentrations (EPC) were used to evaluate risk to aquatic organisms. This may be appropriate for some upper trophic level receptor's exposure; however, amphibians, fish, and invertebrates will be exposed within a singular waterbody. The risk screening needs to be revised to be representative of the exposures to which aquatic organisms within specific waterways will be exposed.

 P4 Response (SC-69)*: Agreed. Although some ephemeral surface water stations are likely too small to support aquatic life, Site-wide EPCs in Table 6-16 (and in Table A4-21) have been replaced by the Site-wide maximum detected concentration to identify risk drivers. A waterbody-specific evaluation was not done in Section 6.0; such an evaluation would be redundant with Section 4.4 and Drawings 4-9 and 4-10 in this RI, which compare waterbody-specific concentrations to screening criteria.*

Drawings

70. The geologic cross sections illustrate a dearth of groundwater monitoring wells, resulting in suspected/inferred groundwater elevations and flow directions. For example, sections B-B' and P-P' only have one monitoring well, and the others only show two monitoring wells. If possible, add more data to the cross sections, such as projecting other wells and sample results to form a more complete picture of the CSM and COC Fate and Transport.

 P4 Response (SC-70)*: Because of the size of the Site, the data points are spaced at considerable distances from each other. It is possible to bring these points together in the direction of a cross section, but bringing them in from the lateral distances involved does not provide a representative (or clearer) picture. Surficial geology including contacts, strike and dip of bedding, and structures has to be utilized. This is why the sections are indicated as "schematic" and are used to convey concepts. We have added MPW022 to Drawing 5-3.*

71. Drawing 2-2

Change the symbol for MMW019 to represent a local aquifer monitoring well.

Change the symbol for MMW004 to represent a local aquifer monitoring well.

> ***P4 Response (SC-71)****: MMW019 symbol has been revised to a local aquifer monitoring well. As shown on Table 3-5, the screened interval is unknown for MMW004. It can be assumed based on the location and depth of this well that is screened in the local aquifer, but this cannot be confirmed. For this reason, the symbol for MMW004 has not been revised.*

72. Drawing 2-3

Show the groundwater elevation in the Wells Formation.

The schematic groundwater flow vector in the Wells Formation' indicates downward flow, but text describes flow to the north. Is there a downward component of flow? If so, provide data to support this assertion. Similar comment for the Dinwoody Formation flow vectors – text (and Figure 5-3) describes possible flow to north along the axis of syncline, not eastward

The selenium concentration of 0.017 mg/L in MMW022 is from 2008. Yet the selenium concentration was approximately 0.045 mg/L in 2014. It is unclear why this drawing presents an older, lower concentration of selenium. Either provide justification for this, or update with the more recent concentration.

> ***P4 Response (SC-72)****: Because the dominant flow directions in both the Dinwoody and Wells Formations are perpendicular to the section, the flow arrows are confusing. The drawing has been revised to help clarify the relevant flow patterns. Please note that the downward flow arrow on the Wells Formation indicates flow along bedding to the groundwater table where flow is then to the northwest. Addition of an inferred potentiometric surface will help depict that flow path.*
>
> *The purpose of presenting the concentrations was to illustrate a uniform picture of the Site at one time as possible, not to present maximum concentration regardless of when they occurred. Data from 2008 was selected based on when the drawings were originally developed and the completeness of the data set. A note has been added to the drawings to indicate sampling dates and reference Appendix B for a complete table of historical results.*

73. Drawing 3-3

Change the symbols for agricultural wells MAW004, 006 and 007 to represent agricultural wells.

Change the symbols for domestic well MDW0001 to represent a domestic well.

> ***P4 Response (SC-73)****: The symbols on Drawing 3-3 for monitoring wells as well as agricultural and domestic wells indicate the screened geologic unit based on drilling logs. For example, MDW001 is screened in the local aquifer, and MAW006 is screened in the Dinwoody Formation. A general symbol is used for wells when the screen interval is unknown or if the well is screened over multiple aquifer. An acronym list of well descriptors (e.g., MAW – agricultural well) has been added to Drawings 3-3 and 4-11.*

74. Drawing 4-11

Show interpreted flow directions for alluvial and bedrock groundwater flow systems.

For direct-push boreholes (BH) that exceed the selenium MCL, highlight or bold to demonstrate exceedances; alternately, shade the general impacted area.

Expand this drawing to the northwest to show the location of Henry Springs, and include sample results for Henry Springs (as this spring is described as a discharge for the Wells Formation).

Show other sample results (for example, results of MAW004, 006, and 007). These agricultural wells would appear to be important potential receptors.

MDW001 is shown, but no sample results are shown; according to Table 3-4, this well is not part of the sampling protocol. Add wells MDW003, MAW003, and MDW005 and include any sampling results.

> ***P4 Response (SC-74)****: The suggested changes have been made with the exception of showing data for the Henry Springs (see response to SC-8).*

75. Drawing 5-2

Based on this cross section, the Dinwoody Formation below MWD085 would be a very good placement for a monitoring well to evaluate COC migration from the waste rock into this aquifer.

Show the groundwater flow direction in the Wells Formation.

> ***P4 Response (SC-75)****: Regarding the Dinwoody, please see responses SC-49 and SC-54. A note has been added to the drawing indicating that groundwater flow in the Wells Formation is into the drawing to the northwest.*

76. Drawing 5-3

Show the groundwater elevation and flow directions in the Wells Formation.

Add MPW022 and sample results.

Add MSP055 and sample results.

> ***P4 Response (SC-76)****: The suggested edits/additions have been incorporated into Drawing 5-3.*

77. Drawing 5-3

Label the sliver of waste rock (?) overlying the Dinwoody Formation and Qw between Stations approximately between 1300 and 2000.

Note that having an additional Dinwoody Formation monitoring well north/northwest of this section, under MWD085, would allow for extending this cross section to the north to illustrate a larger picture of groundwater elevations and apparent gradient in the Dinwoody Formation, and provide a more complete CSM. As noted previously, lack of a Dinwoody Formation monitoring well under MWD085 is considered a data gap that should be addressed; see General Comment B for direction.

> ***P4 Response (SC-77)****: The sliver of waste rock pile MWD088 on Drawing 5-4, Section V-V', has been labeled. Drawing 5-3 is Section N-N', which does not cross MWD088. See responses SC-54 for discussion of the Dinwoody Formation and waste rock dump MWD085.*

78. Drawing 5-4

Reference somewhere that Drawing 2-2 shows the location of Cross Section V-V'.

> ***P4 Response (SC-78)****: Notes have been added to Drawings 5-2, 5-3, and 5-4 indicating that all the cross sections drawn for the Henry Site are indexed on the Drawing 2-2 (which also provides the site geology).*

Appendix A – Risk Assessment

79. Appendix A; Page 2-2

Suggest additional bullet to BRA representativeness list:

- Human representativeness: Are surface soils and sediments sized to represent particles likely to adhere to skin and consequently ingested? If not, discuss as an uncertainty.

https://semspub.epa.gov/work/HQ/100000133.pdf

> ***P4 Response (SC-79)****: The referenced document is applicable to evaluation of lead-contaminated sites where lead shot may be present, and is not applicable to the P4 Sites based on site history and the nature of the contamination that is present. Therefore, we do not believe that a discussion of particle size is appropriate for the representativeness bullets on Page 2-2. However, the final bullet of Section 6.1 of Appendix A has been revised to include a discussion of soil particle size as related to oral exposures.*

80. Appendix A; Page 3-1

Update risk estimates using the most recent version of the EPA Superfund Exposure

Factors (2014): https://www.epa.gov/risk/update-standard-default-exposure-factors

> ***P4 Response (SC-80)****: The primary source for exposure factors used in the Ballard Site BRA was IDEQ (2004), as described in the A/T-approved RI/FS Work Plan; these exposure factors have been retained in the Henry Site BRA for consistency between the P4 Sites. The updated USEPA exposure factors are not significantly different from the IDEQ exposure factors used in BRAs for the Ballard and Henry Sites.*

81. Section 3.1; Page 3-2; Paragraph 3; Last sentence

Add to Section 3.1 that EPA Regional Screening Levels (RSLs) (2015a) were also used in the screening process of constituents of potential concern (COPC) in surface and groundwater. Use the most updated citation of the RSLs (May 2016) if indeed values evaluated for the Henry Site are the same as EPA 2015 RSLs.

> ***P4 Response (SC-81)****: Please note that USEPA RSLs currently are listed under surface water as source number 3, and under groundwater as source number 1 on Page 3-3. At the time of selection of COPCs, the most current version of the USEPA RSLs was November 2015. However, prior to submittal of the draft Henry RI Report in August 2016 the November 2015 RSLs were compared with the May 2016 RSLs to ensure that the semi-annual revision did not affect the COPC selection for the Henry Site. Text describing this comparison has been added to Section 3.1.*

82. Section 3.1, Page 3-2, Paragraph 3

The National Recommended WQC listed is out of date. The most recently published version is July 28, 2016. Update reference accordingly in the text and tables throughout the report.

> ***P4 Response (SC-82)****: The reference to the USEPA's NRWQC website has been updated to 2016 as requested.*

83. Section 3.1, Page 3-2, Paragraph 3

The EPA's RSL is out of date. The most recently published version is May 2016. Update reference accordingly in the text and tables throughout the report.

P4 Response (SC-83)*: Please refer to the response to SC-81.*

84. Section 3.3, Page 3-4, last paragraph.

As recommended by EPA's ProUCL software, the upper confidence limit (UCL) (95 percent or other) should be used as the EPC and not default to a maximum detected concentration (MDC) that is lower than that UCL. EPA no longer recommends defaulting to the MDC. The MDC is not recommended for risk assessment purposes because for small (for example, n < 10 to 20) or skewed data sets it does not provide the specified 95 percent coverage to the population mean, and for larger data sets it typically overestimates the EPC. If the MDC is below the UCL, then the question should be asked whether the data set is sufficient for risk assessment purposes and whether a data gap exists. While this situation may be unavoidable for some media (for example, as a result of limited numbers of culturally significant vegetation available to sample), the uncertainties it imposes on the risk estimate need to be fully discussed in the uncertainty section of the report. Looking at the EPC summary tables (Tables A3-8 through A3-14), it appears that the maximum detected value was only selected for culturally significant vegetation (CSV), which is unavoidable due to the limited availability of these plant types. Therefore, revise the text to indicate that the recommended UCL from ProUCL was used for all media except for CSV, which limited samples required defaulting to the maximum detected concentrations.

P4 Response (SC-84)*: Text in Section 3.3 has been revised as follows: "The Tier II HHRA evaluated <u>EPCs based on </u>upper-bound average concentrations~~ of EPCs (i.e., the lower of either the maximum detected concentration or the ProUCL recommended 95%, 97.5%, or 99% upper confidence limit [95% UCL; 97.5% UCL; 99% UCL]) on the mean concentration~~, using both RME and CTE<u> exposure</u> assumptions.<u> Tier II EPCs were equal to the ProUCL recommended 95%, 97.5%, or 99% upper confidence limit (95% UCL, 97.5% UCL, or 99% UCL) on the mean concentration for all analytes and media where there were sufficient number of detected sample results to perform statistical evaluations. For analytes and media with insufficient detected sample results (e.g., several analytes in upland culturally significant vegetation tissue), the EPC was equal to the maximum detected concentration.</u>"*

85. Section 3.3.1.2; Page 3-6; Paragraph 3

The document states: "A review of the USEPA's Exposure Factors Handbook (USEPA, 2011) indicates that only about 1% of inhabitants in the Western U.S. consume wild game, and less than 1% (i.e., 0.6%) of Native Americans consumes wild game. Furthermore, mean intake rates of wild game by Western U.S. residents and Native Americans are 0.012 grams per kilogram per day (g/kg-d) and 0.001 g/kg-d, respectively. In comparison, mean intake rates for 'total meats' by Western U.S. residents and Native Americans are 1.903 g/kg-d and 2.269 g/kg-d, respectively. As a result, wild game contributes only about 0.63% of the total meat consumed by Western U.S. residents and 0.044% of the meat consumed by Native Americans." The reviewer was not able to locate this information in the 2011 EPA Exposure Factors Handbook; please specify the table, chapter, or the study cited in this document that contains these assertions.

P4 Response (SC-85)*: The percent consuming and per capita consumption rates are presented in Table 11-6 of the 1997 version of the Exposure Factors Handbook (EFH). The 1997 EFH included statistics for consumption of game in Chapter 11, which addresses overall meat consumption, while the 2011 EFH includes statistics for consumption of game in Chapter 13, which only addresses home-produced food. Table 13-41 of the 2011 EFH indicates that approximately 1% of people in the west consume game, consistent with Table 11-6 of the 1997 EFH. Table 13-41 does not have a percent consuming for Native Americans. Because the 2011 EFH does not have statistics for Native*

Americans, 1997 EFH Table 11-6 statistics for percent consuming wild game were retained in text. The text in Section 3.3.1.2 has been modified to remove the per capita meat ingestion rates.

86. Section 3.3.1.2; Page 3-6

If the mean is the average of 1 percent of consumers and the 99 percent who don't consume, then this a misleading statement. Because the purpose of the risk assessment is to assess the risk to exposed people, it is inconsistent to estimate exposure factors by averaging rates of exposed and unexposed people. The risk to people consuming wild game must be based on *their consumption rate,* not the average of consumers and nonconsumers. Based on this text, it appears that game consumption rates were significantly underestimated. The consumption rate should be based on an upper percentile estimate of consumers; not a per capita estimate. The 2011 EPA Exposure Factors Handbook should be referenced to correct this value.

***P4 Response (SC-86)**: The purpose of text in Section 3.3.1.2 is to indicate that game consumption rates in the western United States and among Native American populations are low, and therefore there is minor uncertainty associated with evaluating only one game species (i.e., elk). Text comparing per capital game ingestion rates to per capita meat ingestion rates has been removed from Section 3.3.2.1 the revised BRA. Please refer to P4's response to SC-87 for a discussion of the game ingestion rates that are used in the Henry Mine BRA.*

87. Section 3.3.1.2, P3-6, Paragraph 3

The wild game consumption rates provided in this section seem to be quite low for those populations that do consume wild game; these rates could not be located in the referenced document by this reviewer to verify. Provide additional information on where these rates were taken.

***P4 Response (SC-87)**: Consumption rates for wild game are consistent with rates used in the approved Ballard Site BRA, and were derived as described in footnote s to Table A3-7:*

> *The ingestion of game rates for a seasonal hunter were time-weighted ingestion rate for ages 16-46 from Table 13-41 of USEPA's Exposure Factors handbook (2011b) and adjusted for 29.7% meat preparation and cooking loss and 29.7% post-cooking loss (Table 13-69 from USEPA 2011b), consistent with the human health risk assessment technical memorandum for the Smoky Canyon Mine Site (Formation Environmental LLC, 2013). The CTE (mean) and RME (99th percentile) adult Native American ingestion of game rates were obtained from Table 11-6 of the 1997 Exposure Factors Handbook (USEPA, 1997b). The child Native American ingestion rates were estimated from the adult ingestion rates assuming a child eats 45% of the meat consumed by an adult (based on values in Table 13-1 of USEPA, 2011b). All grams per kilogram per day adult ingestion rates were converted to grams per kilogram assuming a body weight of 70 kilograms.*

88. Appendix A; Page 3-8

Consider globally replacing "receptors" with "exposed" or "potentially exposed people."

***P4 Response (SC-88)**: Comment Noted. "Receptors" is common risk assessment terminology for the potentially exposed populations being evaluated, as defined in Section 3.3.1.2. Because "receptors" is a simple term with one meaning within the risk assessment, it can be used in a variety of sentence formats without the ambiguity that might occur with a longer phrase such as "potentially exposed people."*

89. Section 3.3.2.1, Page 3-11, last paragraph, last sentence

See previous comment regarding the MDC. EPA's ProUCL software, the UCL (95 percent or other) should be used as the EPC and not default to an MDC that is lower than the UCL. EPA no longer recommends defaulting to the MDC.

> ***P4 Response (SC-89)****: Please refer to the response to SC-84.*

90. Appendix A; Page 3-12

Use the most recent version of ProUCL Software (v. 5.1) available at:

https://www.epa.gov/land-research/proucl-software

> ***P4 Response (SC-90)****: The 95% UCL on the mean concentrations for Henry Site datasets were calculated prior to the release of ProUCL v 5.1. However, comparison of a subset of Site EPCs calculated using ProUCL v. 5.1 to EPCs calculated using ProUCL v. 5.0 indicates that risk estimates recalculated based on EPCs derived using ProUCL v. 5.1 differ only slightly (if at all) from current risk estimates. Based on the above, P4 believes that the level of effort required to recalculate EPCs for all COPCs and COPECs in all media based on ProUCL v. 5.1 is not warranted.*

91. Section 3.3.2.2; Page 3-12

Suggest moving all this section as a new attachment (Exposure Estimation Equations for HHRA).

> ***P4 Response (SC-91)****: Comment noted. Although this section is lengthy, it contains information that reinforces methods described elsewhere in the report, and is most appropriate as a subsection to Section 3.3.2.*

92. Appendix A; Page 3-24

Replace the outdated IRIS Uranium RfD with the ATSDR oral MRL value (see attached correspondence expressing support from EPA Head Quarters): http://www.atsdr.cdc.gov/toxprofiles/tp150.pdf

> ***P4 Response (SC-92)****: Please refer to the response to GC-C.*

93. Appendix A; Page 3-27

The EPA preliminary remediation goal calculator can accept user-derived exposure or toxicity values included in the Particle Emission Factor.

> ***P4 Response (SC-93)****: The particulate emission factor (PEF) used in inhalation dose calculations for chemicals in the BRA for the Henry Site was calculated using the PEF equation in Appendix D of the USEPA's Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (USEPA, 2002) and default parameter values in Idaho Department of Environmental Quality's (IDEQ's) Idaho Risk Evaluation Manual (IDEQ, 2004), including a default value for the variable Q/C_{wind}. The EPA calculator, which was used to calculate preliminary remediation goals (PRGs) for radium-226 in the BRA for the Henry Site, does accept user-derived values for the site area (A_s), mean annual windspeed (U_m), equivalent threshold value (U_t) fraction vegetated cover (V), and (by default, given U_m and U_t), f(x). However, The value of Q/C_{wind}, is calculated in the calculator based on the user-input A_s and user-input climatic zone. The value of Q/C_{wind} generated by the calculator for Boise, Idaho is significantly different than the value of Q/C_{wind} in IDEQ (2004), which is approximately equal to the Q/C_{wind} value for a 0.5 acre site in Boise, Idaho from USEPA (2002). It should be noted that the values of the constants A, B, and C used to calculate the Q/C_{wind} in the EPA's online preliminary remediation goal calculator are significantly different than the values of these constants in Appendix D of USEPA (2002).*

The PEF value in the EPA's calculator could have been matched to the PEF value calculated from IDEQ (2004) by inputting a made-up value, rather than the standard default, for a user-provided input parameter. However, the contribution inhalation of contaminated dust makes to the total radiological dose is much less than the contribution from incidental ingestion of soil, and completely insignificant compared with the contribution due to external exposure to radiation associated with contaminated soil. Because the PEF will not affect the outcome of the BRA for radium-226, the calculator was not artificially manipulated to achieve a desired PEF.

94. Section 4.1.1.2; Page 4-2; Paragraph 2; After Line 11

It appears that not the same constituents were selected as constituents of potential ecological concern (COPEC) in upstream, downstream, and pond surface water. For example, cobalt, copper and thallium were selected in downstream and pond surface water, but not in upstream water (Table A4-3). Antimony was selected in upstream and pond surface water, but not in downstream surface water (Table A4-4). Please include an explanation in Section 4.1.1.2 for not selecting the same list of constituents in all surface water samples tested at the site (Tables A4-3 through A4-5).

Incorporate some text in this section regarding the final 2016 Aquatic Life Ambient Water Quality Criterion for Selenium in Freshwater and the fact that new values are available for lotic and lentic surface waters but that P4 used the draft value of 0.005 mg/L.

P4 Response (SC-94)*: Separate screening tables were created because hardness, and therefore hardness-dependent criteria for some metals, varies between upstream, downstream, and pond surface water sampling locations. The list of analytes is not identical between Tables A4-3 through A4-5 because Screening tables for all media include only detected analytes. The final surface water COPECs listed in Table A4-7 includes all COPECs identified in Tables A4-3 through A4-5. Text in the first paragraph of Section 4.1.1.2 has been revised to clarify this point.*

Regarding the use of the final 2016 Aquatic Life Ambient Water Quality Criterion for Selenium, please note that the text does cite the new selenium criterion for lotic systems However, the criterion was released after the screening had been performed, and because selenium was already a COPEC based on existing criteria, Tables A4-3 through A4-5 were not updated in the draft report. In the revised report, the screening value for lentic systems has been added to the final paragraph of Section 4.1.1.2, and the new criteria for lotic and lentic systems have been added to Tables A4-3 and A4-4 (lotic criterion) and A4-5 (lentic criterion).

95. Section 4.2, Page 4-3, last paragraph, Sentence 1

Suggest removing the word "process" from this sentence so it reads more clearly.

P4 Response (SC-95)*: The word "process" has been replaced by "ERA."*

96. Section 4.2.1.1, Page 4-4, Paragraph 2, Sentence 1

Suggest revising "Disregarding the influence of environmental contaminants …" to read as "Disregarding the influence of environmental contaminants and physical disturbance …"

P4 Response (SC-96)*: Agreed; text has been modified as requested.*

97. Section 4.3.1; Page 4-21; Paragraph "Amphibian and Fish/American Goldfinch"

Although the methodology used to assess the risk of amphibians is appropriate, in the case of fish it would be more appropriate to use fish tissue data when available. It appears that some tissue data has been collected (Table 4-18); if the species of these forage fish (redside shiners, speckled dace) tissue concentrations are available then it would be valuable to incorporate these data in the ERA. Otherwise, an acknowledgement of the lack of this information and how this affects the overall risk assessment should be mentioned in the uncertainty section.

The HQ for the American goldfinch for silver is 0.12, so delete silver from the list of COPCs exceeding an HQ of 1.

P4 Response (SC-97)*: Fish tissue data have been added in a table embedded in text and evaluated qualitatively.*

Silver has been deleted from the list of COPECs exceeding an HQ of 1 for the American goldfinch.

98. Section 4.3.2; Page 4-24; Paragraph 3; Lines 2-5

Modify the text to read similar to: "Excess hazard associated with antimony in the Henry Mine upland soil was also calculated for deer mouse and mink; however, similar to the long-tailed vole, hazards associated with antimony in upland soil for these two constituents was greater at background location than at site."

P4 Response (SC-98)*: Please clarify if the intent of this revision is to add the mink to this paragraph. This change has not made, as the mink is a riparian receptor and is not exposed to upland soil. However, as noted in the response to SC-61, which requested that the presentation of risk results in Section 6.6.2 of the RI be receptor-specific, comparisons between hazards for Site and background media and conclusions regarding risk drivers have been moved to a new Section 4.3.3 of Appendix A. Similarly, text comparing hazards for Site and background media have been moved from receptor-specific results in Section 6.6.2 of the RI to Section 6.9.4 of the RI.*

99. Section 4.3.2; Page 4-25; Paragraph 2; Lines 2-5

Modify the text to read similar to: "Excess hazard associated with antimony in the Henry Mine upland soil was also calculated for long-tailed vole and mink; however, similar to deer mouse, hazards associated with antimony in upland soil for these two constituents was greater at background location than at site."

P4 Response (SC-99)*: Please refer to the response to SC-98.*

100. Section 4.3.2; Page 4-25; Last Paragraph

Change the range to 0.013 to 3.8 or revise the LOAEL-based value for thallium in Table A4-25.

P4 Response (SC-100)*: The hazard for thallium was inadvertently reported as 0.031 in text, and has been revised to 0.013.*

101. Section 5.1; Page 5-1; Paragraph 4; Last Sentence

The document cites Table 7-4 of the Conda/Woodall Mountain Mine RI/FS Site-Specific Livestock Risk Assessment Problem Formulation (Formation Environmental, 2013). This citation is accurate; however, it would be more appropriate to cite the 2016 Final Livestock Risk Assessment Report Conda/Woodall Mountain Mine. Table 4-4 of this document has toxicity reference values for Evaluation of Drinking Water Ingestion by Livestock – Other Chemicals of Interest. Please cite this final document.

P4 Response (SC-101)*: Agreed. The updated reference has been cited in the revised report.*

102. Section 5.2.1.1; Page 5-3; Paragraph "Livestock grazing"

It would be helpful to provide additional details in this section (for example, grazing allotment areas [if any], acreage of each allotment area, any restrictions in any of these grazing areas resulting from elevated selenium concentrations, and a map with the location of these grazing areas within the Henry Mine Site).

> ***P4 Response (SC-102)**: The LRA is a conservative hypothetical evaluation that utilizes Site-wide EPCs to evaluate potential risks to future livestock grazing anywhere on-Site; risks to livestock were not evaluated based on current or potential future grazing allotments. Therefore, this information is not applicable to Appendix A of the RI. However, the requested information will be described in Section 2.0 of the revised RI Report and the future Henry Site Feasibility Study (FS), as it relates to evaluation of remedial measures including best management practices (BMPs) and/or institutional controls (ICs).*

103. Section 5.2.1.2; Page 5-4; Paragraph "Terrestrial environment;" Last Line

This citation is partially accurate. "…adverse toxicity effects from toxicity adverse effects from toxicity may be reversed if the adverse effects did not include developmental deformities" could not be found in USDOI, 1998. Cite appropriate document or delete this portion of the text.

> ***P4 Response (SC-103)**: The second paragraph on page 143 of the referenced document (USDOI, 1998) states: "<u>Selenium accumulates in and disperses from animal tissues fairly rapidly. Significant changes in tissue selenium status can occur within days, weeks, or months depending on the response criterion of interest and the target tissue being monitored (Wilber 1980; Bennett et al. 1986; USFWS 1990a; Heinz et al. 1990; Heinz and Fitzgerald 1993a; Heinz 1993). Furthermore, the overt symptoms of even near-fatal selenium poisoning in adult birds and mammals can be reversed quickly if the source of selenium exposure is eliminated (Ruta and Haider 1989; Heinz and Fitzgerald 1993b). By contrast, embryonic deformities caused by selenium poisoning are not reversible (Lemly 1993b), nor are some types of tissue damage in adult animals (Sorensen 1991).</u>" No changes to the text were necessary.*

104. Table A3-1

- Change the nomenclature of the analyte Radium-226 to Radium-226+D in the analyte column and in note "d". The PRG value for Ra-226+D (radium+ daughter products) using the EPA's PRG calculator as a default for soil is 0.0063 picoCuries per gram (pCi/g); however the value for Ra-226 is 1.15E-02 pCi/g.
- The notes indicate: "All the concentrations in mg/kg except for radium-226, which is in picoCuries per kilogram (pCi/g)." There is an inconsistency in the units in the text and what is shown in parenthesis. Please change the text to picoCuries per gram.
- Note "b" has a typo.

> ***P4 Response (SC-104):** The analyte column lists constituents as they are identified in the analytical results, rather than as the form for which screening values are available/selected. Footnote d has been corrected to indicate that radium-226 was screened against the PRG for Radium-226+D, rather than radium-226. Additionally, the "*picoCuries per kilogram*" typo in the first note has been corrected to read "*picoCuries per gram*" and the "ths" typo in footnote b has been corrected to read "this."*

105. Table A3-3

Note 3 needs to indicate that the RSL Resident Tapwater for carcinogens corresponds to a cancer risk of one in 1 million (TR=1E-06), and for noncarcinogens the HQ is equivalent to 1. Please provide the rationale for using an HQ of 1 for surface water instead of the HQ of 0.1 used in upland soil and sediments (Tables A3-1 and Table A3-4). This information should also be included in Section 3.1.1 (Surface Water) of Appendix A.

> ***P4 Response (SC-105):*** *Note 3 has been revised to indicate that the RSL Resident Tapwater for carcinogens corresponds to a cancer risk of one in 1 million (TR=1E-06), and for noncarcinogens the HQ is equivalent to 1. The use of RSLs based on an HQ of 1 is consistent with the <u>RI/FS Work Plan</u> and with the Ballard Site BRA. The use of RSLs based on a target HQ of 1 is also consistent with the HQ basis of other surface water screening criteria in Table A3-3, including State of Idaho Surface Water Quality for Domestic Water Supply Use (IAC, 2009) and National Recommended Water Quality Criteria (USEPA, 2015).*

106. Table A3-3

This surface water screening inappropriately uses dissolved concentrations. The standards for protection of human health (DEQ's domestic use, and EPA's MCLs and PRGs) are based on <u>total</u> metals concentrations. The surface water screening tables should be revised to include total concentrations similar to that presented for groundwater.

> ***P4 Response (SC-106):*** *Please note that the surface water sampling program for the P4 Sites measures dissolved concentrations for all COPCs, except selenium, as described in the <u>2009/2010 Surface Water Sampling and Analysis Plan</u> (MWH, 2009). In addition, background levels were developed for dissolved concentrations of all COPCs in surface water, with the exception of selenium, as described in the 2013 <u>Background Levels Tech Memo</u> (MWH, 2013). As a result, the available surface water data for all metals and metalloids are expressed as dissolved concentrations.*

107. Table A3-5

Footnote "f" (indicating that these constituents were eliminated from further consideration as a result of their low toxicity and being essential nutrients) is unnecessary since none of measured concentrations exceed screening levels, which is a better indicator of the protectiveness.

> ***P4 Response (SC-107):*** *The only essential nutrient with an available screening criterion is iron. Although iron does not exceed this screening level, footnote "f" has been retained for all essential nutrients because low concentrations and essential nutrient status are equal indicators of protectiveness. According to the COPC selection methodology used in the Henry BRA, constituents without screening levels are retained for quantitative risk evaluation. In this case, were it not for the "essential nutrient status" calcium, magnesium, potassium, and sodium would have been retained as COPCs.*

108. Table A3-6

Again, footnote "a," which indicates surface water COPCs are all in the dissolved form except for selenium, is not correct. Total concentrations should be used for screening versus human health standards.

> ***P4 Response (SC-108):*** *Please refer to the response to SC-106, above.*

109. Table A3-13

The two occurrences of "surface water stations" should be changed to "sediment stations" since this is the sediment summary statistics table.

> ***P4 Response (SC-109):*** *Table A3-13 has been modified as indicated.*

110. Table A3-30

Note "a" indicates that risk estimates for all COPCs are presented in Attachment C. Attachment C presents Tier I background and Human Health Risk Calculations, not Tier II calculations. Please change this reference to Attachment D.

> ***P4 Response (SC-110):*** *The reference has been changed to Attachment D.*

111. Table A4-1

The column Lowest Soil Screening Level appears to have some inconsistencies. For example, the constituents arsenic, manganese, nickel, and silver are not the lowest concentrations from all of the screening values provided. Make appropriate changes or provide rationale for the selection of the lowest soil screening level in the table's notes and in Section 4.1.1.1 of Appendix A.

> ***P4 Response (SC-111):*** *The noted inconsistencies have been corrected in the revised BRA. Please note that this correction did not affect the ecological screening results.*

112. Table A4-2

The column "Lowest Soil Screening Level" appears to have some inconsistencies. For example, nickel and silver are not the lowest concentrations from all the screening values provided. Make appropriate changes or provide rationale for the selection of the lowest soil screening level in the table's notes and in Section 4.1.1.1 of Appendix A.

> ***P4 Response (SC-112):*** *The noted inconsistencies have been corrected in the revised BRA. Please note that this correction did not affect the ecological screening results.*

113. Table A4-3

Revise the hardness value used for the State of Idaho Standards Aquatic Life to 400 mg/L in note "a" to be consistent with statements in Section 4.1.1.2. Provide the reason(s) why cobalt was not included in the list of analytes in Table A4-3. This is inconsistent with the information presented in Table A4-7 (that is, cobalt is a constituent of potential concern in surface water).

> ***P4 Response (SC-113):*** *The hardness typo in footnote "a" has been corrected as noted. Cobalt is not included in COPEC screening for upstream surface water in Table A4-3 because it was not detected (refer to table A2-5). However, cobalt is listed as a COPEC for the Henry Site in Table A4-7 because it was selected as a COPEC in downstream surface water.*

114. Table A4-3

The EPA water quality criteria for aluminum, iron, and selenium are based on total concentrations. This table and any others using dissolved concentrations for aluminum and iron should be revised to include total concentrations for comparisons to these criteria.

> ***P4 Response (SC-114):*** *Please refer to response to SC-106.*

115. Table A4-4

Revise the hardness value used for the State of Idaho Standards Aquatic Life to 256 mg/L in note "a" to be consistent with statements in Section 4.1.1.2.

> ***P4 Response (SC-115):*** *The hardness typo in footnote "a" has been corrected as noted.*

116. Table A4-15

Section 4.2.1.1 indicates that plant tissue concentrations were based on measured concentrations, when available, instead of modeled concentrations. Add a footnote to this table that describes the modeled approach as being used only when sufficient data were unavailable for using measured tissue concentrations.

> ***P4 Response (SC-116):*** *The approach for calculating plant tissue doses is clearly described in text and in applicable tables (e.g., Table A4-22, Table F-1, etc). However, a note indicating that modeled plant tissue concentrations were calculated only when measured plant tissue data were insufficient has been added to the BAF table (A4-15).*

117. Table A4-21

Please provide the rationale for evaluating surface water data as one exposure unit. Although aggregating data for surface water and sediment over the entire site to calculate a 95% UCL of the mean may be appropriate for exposure to upper trophic level wildlife, it is not appropriate for exposure to fish and amphibian populations that are likely to be exposed within individual streams or ponds. The risk to aquatic resources (where present) using ponds and streams need to be evaluated independently.

> ***P4 Response (SC-117):*** *Please refer to the response to SC-69.*

118. Table 6-15 and Table A4-7

Note "b" - It would also be good to point out that the maximum manganese detected in soils at the Henry Mine Site (2,580 milligrams per kilogram [mg/kg]) is below the background level identified in MHW (2015) document (3,460 mg/kg) here and the text of the document.

> ***P4 Response (SC-118):*** *Because the BRA includes calculation of hazard based on background concentrations, background is not used in the screening process. No revisions to the report are necessary.*

119. Table B-27

The chemical-specific HQ for selenium (1.2E-01/5.0E-03) is 24, not 23. Please make appropriate changes in this table and throughout the document.

> ***P4 Response (SC-119):*** *Please note that although numbers shown in tables are rounded, the full value was carried through the calculation, from EPC to hazard estimate. The dose in Table B-27 is actually 0.115 mg/kg-d, corresponding to a HQ of 23. No revisions to the report are necessary.*

120. Table B-30

The chemical-specific HQ for thallium (1.3E-03/1.0E-05) is 130, not 128. Please make appropriate changes in this table and throughout the document.

> ***P4 Response (SC-120):*** *Please note that although numbers in tables are rounded, the full value is carried through the calculation, from EPC to hazard estimate. The dose in Table B-30 is actually 0.00128 mg/kg-d, corresponding to a HQ of 128. No revisions to the report are necessary.*

121. Table B-42

The chemical-specific HQ for selenium (2.3E-01/5.0E-03) is 46, not 45. Please make appropriate changes in this table and throughout the document.

P4 Response (SC-121): *Please note that although numbers shown in tables are rounded, the full value was carried through calculation, from EPC to hazard estimate. The dose in Table B-42 is 0.225 mg/kg-d, corresponding to a HQ of 45. No revisions to the report are necessary.*

122. Table J-1

The ecological hazard for selenium (1.2/1.4E-01) is 8.6, not 8.2. Please make appropriate changes in this table and throughout the document.

P4 Response (SC-122): *Please note that although numbers shown in tables are rounded, the full value was carried through calculation, from EPC to hazard estimate. The dose in Table J-1 is 1.17 mg/kg-d, and the TRV is 0.143 mg/kg-d, corresponding to a HQ of 8.2. No revisions to the report are necessary.*

Appendix C – Photographic Log

123. Appendix C; Page 1 of 6; Photo Location MST052

The sign in the photo indicates that this is site MST051. Reconcile.

P4 Response (SC-123): *This photo has been removed from the revised report as the photo for MST051 is located on Page 11 of the appendix.*

Editorial Comments Table

Henry Mine

Editorial Comments

Item No.	Section; Table; Figure	Page	Paragraph	Line (if not obvious)	Agency/Tribe Comments	Did P4 Respond to Comment
	ES.4	ES-3	4 “Riparian Soil”	2	Delete second “investigations” as it is redundant.	
	ES.4	ES-3	3	Sentence 1	Insert “the” to read “… summary of the principal findings for the RI program …”	
	ES.4.1	ES-4	2	10	Delete “reclaimed” as it is redundant.	
	List of Drawings	ix	Drawing 5-2		There is no reference to this drawing in the text. Revise accordingly.	
	Acronyms and Abbreviations	xi			“ILCRs” is not in alphabetical order. Correct.	
	1.0	1-1	1	8	Insert “and” to read “… and the Shoshone-Bannock Tribes (Tribes).”	
	1.2.2.	1-4	Footnote	2	Delete “numeric” as it is redundant.	
	1.2.3	1-6	1 (partial)	4	Change to “Engineering Evaluation /Cost Analysis (EE/CA).”	
	1.2.3	1-6	2 (last)	1	Insert “into” to read “… entered into a new …”	
	2.3.2	2-5	5 (last)	1	Insert a comma to read “(i.e., MDS016).”	
	2.4	2-7	3 (last)	2	Insert a period to read “Oberlindacher, et al. (1982)” for consistency.	
	2.5.2	2-10	1 “Grasses”	1	Insert a space to read “*Bromus inermis*.”	
	2.6.2	2-13	3 (last)	3	Insert “road” to read “… P4 Enoch Valley haul road traverses …”	
	2.6.2.2	2-14	3 (last)	3	Insert “how” to read “… and ultimately how wells and …”	
	2.6.2.2	2-16	1	4	Insert “is” to read “… which is at a depth …”	
	2.6.2.2	2-16	1	Sentence 4	Change to read “The temperature data appear to respond to seasonal fluctuations …”	
	2.6.2.2	2-16	2 (last)	3	Insert a comma to read “… Enoch Valley Mine, is …”	

Henry Mine

Editorial Comments

Item No.	Section; Table; Figure	Page	Paragraph	Line (if not obvious)	Agency/Tribe Comments	Did P4 Respond to Comment
	2.6.2.2	2-20	1 (partial)	4	Replace "and as" with "which" to read "… producing a "noisy" hydrograph, which is typical …"	
	2-7	2-21	1	3	Insert "in" to read "… discussed in the *Area-Wide Assessment* …"	
	2.10.1	2-24	3	2	Change to "Table 2-7."	
	2.10.2	2-27	2	3	Change "freshwater criteria" to "surface water criterion."	
	3.5	3-7	4	7	Change "Section 3.6.3" to "Section 4.6.3."	
	4.3	4-15	2	6	Change "was" to "were" for subject-verb agreement to be consistent with the rest of the document where data is treated as plural. Check all instances to make sure this is consistent throughout the report.	
	4.4.1	4-23	3	2	Change "are exceeded" to "exceed" to read "… and often only exceed in one …" for easier reading.	
	4.4.1	4-24	1 (partial)	Sentence 2	Change to "exceeds" and "criterion" to read "… and there is only one sporadic or anomalous result that slightly exceeds the hexavalent chromium screening criterion, chromium is not discussed further.	
	4.4.2	4-26	2	5	Insert "spring" to read "… with spring exceedances of the selenium …"	
	4.4.4.1	4-29	2	6	Change to "criterion" to read the "… the screening criterion for cadmium …" Check the entire document for instances where the singular criterion should be used in lieu of the plural criteria.	
	4.4.4.1	4-30	1	3-4	Change to "criterion" for both occurrences.	
	4.4.4.1	4-31	2	Sentence 2	Delete "at" to read "Dissolved arsenic concentrations range from …"	
	4.4.4.2	4-31	3	Sentence 3	Change to "stations" to read "… for these stations are reported …"	
	4.5	4-34	5 (last)	3	Change "is" to "are" to read "Groundwater samples collected and analyzed from these wells are used …" for subject-verb agreement.	

Henry Mine

Editorial Comments

Item No.	Section; Table; Figure	Page	Paragraph	Line (if not obvious)	Agency/Tribe Comments	Did P4 Respond to Comment
	4.5.2.1	4-41	4 (last)	3	Delete "a" to read "… (SMCLs are used as reference points …"	
	4.5.3	4-51	2	Sentence 2	Add a hyphen to read "… piper diagram – Figure 4-23 – to evaluate …"	
	4.6.1.2	4-56	4	3	Delete the comma after "soil" to read "… or potential species use, soil and vegetation selenium …"	
	5.1.1.1	5-3	2	6	Change "were" to "where" to read "Therefore, the areas where mass wasting …"	
	5.1.2.2	5-4	5 (last)	2	Should it be "Detail A1" as opposed to "Detail A?" Revise accordingly.	
	5.1.2.2	5-5	1 (partial)	2	Change to "Details B2 and B3)."	
	5.1.4	5-7	2	3	Change "affects" to "affect" for subject-verb agreement.	
	5.1.4	5-7	4 (last)	1	Change to "Sections 2.1 and 2.4."	
	5.1.4	5-7	4 (last)	6	Insert "and" to read "…bedding and is either …"	
	5.1.4.3	5-10	2	11	Insert "the" to read "… flow towards the northwest …"	
	5.2	5-13	3	1	Switch the period and quotation mark to read "analyte specific."	
	5.3.3	5-18	3 (last)	2	Change to "Little Blackfoot River."	
	5.3.3	5-16	4	1	Change "affect" to "effect."	
	5.3.3	5-20	3	3	Change to "concentrations."	
	5.3.4	5-20	3	6	Delete "a" to read "…events at MMW010)."	
	5.3.4	5-20	3	8	Add "they" and change to "exceed" to read "… and they rarely exceed background levels."	
	5.3.4.1	5-21	1	4	Insert "a" to read "… is a more significant pathway."	
	5.3.4.1	5-21	3	Sentence 4	Change to "…directed northerly toward the river and then to a more westerly direction …" as it seems to read more smoothly.	

Henry Mine

Editorial Comments

Item No.	Section; Table; Figure	Page	Paragraph	Line (if not obvious)	Agency/Tribe Comments	Did P4 Respond to Comment
	5.3.4.1	5-23	3 (last)	13	Change "verses" to "versus."	
	5.3.4.3	5-26	2	Sentence 1	Change "… flow path that experiences reducing conditions …"	
	7.2.5	7-7	2	9	Change to "COC" to read "… as a preliminary COC for direct …"	
	7.2.6	7-8	5 (last)	1	Change "not affects" to "no effects."	
	7.2.8	7-11	2	5	Insert a semicolon to read "… noncancer criterion"	
	7.2.9	7-13	3	11 (last)	This reader is not sure what is meant be "detected Site." Revise.	
	7.3	7-14	4	1	Change to "These ecological risk estimates …"	
	Note 4	2-1			Change "of" to "for" to read "… accounts for the topography."	
	Note Orange shaded	4-9		2	Change "levels" to "level" to read "Selenium action level is …" for subject-verb agreement.	
	Drawing 2-3				Reference somewhere that Drawing 2-2 shows the location of Cross Section B-B'.	
	Drawing 5-2				Reference somewhere that Drawing 2-2 shows the location of Cross Section P-P'.	
	Drawing 5-3				Reference somewhere that Drawing 2-2 shows the location of Cross Section N-N'.	

P4 Response (editorial comments): *These comments have been addressed in the revised report.*

RHS Ralston Hydrologic Services, Inc.
GROUND WATER CONSULTING AND EDUCATION
1122 East B Street, Moscow, ID USA 83843
Voice and FAX 208-883-0533, E-mail ralston@moscow.com

MEMORANDUM

To: Cary Foulk, MWH
From: Dale Ralston, RHS
Subject: Review of "Wells Formation Groundwater Review and Scoping Comments
Date: May 24, 2010

The purpose of this memo is to provide you with my thoughts relative to the document entitled **"Wells Formation Groundwater Review and Scoping Comments"**, dated May 12, 2010. The author of the document is not identified.

Document Summary

The document under review provides scoping comments on the hydrogeologic characterization of the Wells Formation in the vicinity of the Ballard, Henry and Enoch Valley mine sites (P4 Mines). The basis for the P4 hydrogeologic conceptual models for these sites is described and then is evaluated using a contour map of water-level elevations that shows predicted directions of ground-water flow. The map was created using water-level data from wells completed in the Wells Formation at the three P4 Mines plus three adjacent mines. Based on analysis of the map, areas are identified near two of the P4 Mines where additional wells completed in the Wells Formation might be needed. The recommended next steps include revision of the conceptual site model and identification and resolution of potential data gaps.

Validity of the Water-Level Contour Map

The document under review includes a plan-view map of ground-water elevations obtained from wells completed within the Wells Formation at six mine sites: 1) Henry, 2) Enoch Valley, 3) South Rasmussen, 4) Ballard, 5) Blackfoot Bridge and 6) Conda. Contours of equal ground-water elevation are shown on the map with contour values ranging from 6,400 feet at the Enoch Valley site to 6,140 feet at the Blackfoot Bridge and Conda sites. The contours shown on the map along with the inferred directions of ground-water flow are based on the assumptions that the Wells Formation acts as a single homogeneous and isotropic aquifer on the scale of the analysis.

The text of the document under review correctly notes that the assumption that the Wells Formation is homogeneous and isotropic is not valid. A number of authors have shown that the Wells Formation is anisotropic and heterogeneous on a range of scales. On the small to intermediate scale, cross-bedding hydraulic conductivity likely is much less than with-bedding hydraulic conductivity. This hinders ground-water flow at right angle to the axes of synclines and anticlines where the units are dipping. On the larger scale, faults with 100's to 1,000's of feet of offset likely create at least partial barriers to cross-structure ground-water flow and possibly provide preferential pathways for parallel to structure ground-water flow.

An additional deficiency in the preparation of the water-level contour map, not mentioned in the memo, is the underlying assumption that vertical ground-water flow does not occur in the area. A plan view water-level contour map can only be constructed using wells of various depths if vertical hydraulic gradients are minimal. Field data have shown there is a vertical component of ground-water flow within the Wells Formation at a number of sites.

The deficiencies described above greatly limit the utility of the water level contour map presented within the document under review. The water-level contours and the inferred directions of ground-water flow presented in the document under review do not accurately represent the complex hydrogeology of the area near the P4 mines.

General Questions

Three general questions underlie the discussion presented in the document under review.

- First, what do we know about regional ground-water flow patterns in the Wells Formation?
- Second, what do we need to know about regional ground-water flow patterns in the Wells Formation relative to analysis of the three mine sites?
- Third, what can be accomplished by the construction of additional wells completed within the Wells Formation?

A number of authors have concluded that a regional ground-water flow system underlies the western portion of the phosphate mining region, mostly hosted within rocks of the Wells Formation. Much of this work was done by graduate students at the University of Idaho under my direction. The dominant evidence for this flow system is the presence of springs that have the characteristics of a regional ground-water flow system (relatively constant discharge rate, ground-water quality characteristics typical of long ground-water flow systems and age dates is excess of 10,000 years). While the general flow direction is depicted to the northwest, the same authors have concluded that ground-water flow patterns within the regional system are extremely complex, primarily related to the complex structural setting of the Wells Formation on local, intermediate and regional scales.

Knowledge of ground-water flow in the Wells Formation is needed at each of the P4 Mines in order to understand potential and actual pathways for COC transport. Inferring ground-water flow directions over large areas, particularly using water-level data from wells located on the opposite side of large-scale structural features, has limited value. The conceptual site model for each mine site should be based on knowledge of the local site geology and on data from on-site wells. Particular emphasis should be placed on identification of likely discharge areas and the locations of the discharge areas relative to the mine sites. The water dating results indicate that travel times are long within the regional aquifer hosted in the Wells Formation.

Construction of new wells with the specific objective to understanding the regional ground-water flow system in the Wells Formation would necessarily involve placement of boreholes in locations of no data (distant from the existing mine sites). This effort seems to be beyond the scope of normal RI/FS work.

Recommended Next Step

The next steps as outlined in the document under review include the following: 1) assemble groundwater elevation and water quality data and present a more refined CSM for groundwater in the Wells Formation; 2) compile any other lines of evidence that relate to resolving the key questions of interest, 3) identify potential data gaps necessary to complete RI/FS's and 4) propose steps to fill any outstanding data gaps.

I recommend that a plan view presentation of ground-water elevation information be prepared as outlined below.

- The well locations should be shown on a map that shows all of the major structural features (folds and faults) including strike and dip information where possible. The map should be on a scale that is sufficient to allow inclusion of the six mine sites considered in the document under review plus additional nearby mines (i.e. Dry Valley, Wooly Valley…) where Wells Formation ground-water data are available. The water-level elevation should be written near each well location. Contour lines of the equal water-level elevation should not be constructed.
- Text should accompany the map that describes the CSM for each mine site within the context of structurally controlled subareas within the regional aquifer. The plan-view map should show the subarea boundaries.
- To the extent possible, generalized flow lines should be shown on the map for each of the P4 Mines. The flow lines should be based on controls of ground-water flow posed by geologic features (folds and faults) and water-level elevation data from wells.
- The data gap analysis should be based on analysis of locations and depths of existing wells in comparison to the generalized flow lines shown on the map for each mine site. New wells would be recommended only if needed to add detail for the CSM for a given mine site.

Please contact me if you have any questions or need additional information. Thank you.

APPENDIX D-3

A/T's Supplemental Comments on P4's Response to Comments (dated February 6, 2017) on *P4's Henry Mine Remedial Investigation Report, Draft Rev 0, August 2016*

(Second set of A/T comments. Comments on P4's first set of responses.)

Transmitted to P4 on April 13, 2017

UNITED STATES ENVIRONMENTAL PROTECTION
AGENCY
REGION 10
IDAHO OPERATIONS OFFICE
950 West Bannock, Suite 900
Boise, Idaho 83702

April 13, 2017

Molly R. Prickett
Environmental Engineer
Monsanto Company
Soda Springs Operations
1853 Highway 34
Soda Springs, Idaho 83276

Re: A/T Comments on P4's RTCs on Henry Mine RI.

Dear Ms. Prickett,

The Agencies and Tribes (A/T) have reviewed the above referenced deliverable, submitted pursuant to the Administrative Settlement Agreement and Order on Consent/Consent Order for Performance of Remedial Investigation and Feasibility Study at the Enoch, Henry, and Ballard Mine Sites in Southeastern Idaho (or 2009 AOC). This letter transmits comments and direction on earlier responses to comments.

We will be available to discuss these comments in the coming weeks. Based on our review, it appears necessary to resolve remaining comments prior to issuance of a revised draft RI. Please contact me if you have questions. I can be reached at 208-378-5763 or electronically at tomten.dave@epa.gov.

Sincerely,

//s//

Dave Tomten
Remedial Project Manager

Enclosure

cc: Mike Rowe, IDEQ – Pocatello
Jeremy Moore, US FWS - Chubbuck
Kelly Wright, Shoshone Bannock Tribes
Colleen O'Hara, BLM – Pocatello
Sherri Stumbo, Forest Service – Pocatello (electronic version only)
Vance Drain, MWH (electronic version only)

Shannon Ansley, Shoshone Bannock Tribes (electronic version only)
Dennis Smith, CH2MHill (electronic version only)
Gary Billman, IDL – Pocatello (electronic version only)

A/T Comments, P4's Responses, and A/T Follow-up Comments

Henry Mine Remedial Investigation (RI) Report

(Revision 0, August 2016)

General Comments

(Note: Final verification of responses will occur when Draft Final is submitted.)

A. Several portions of this report refer the reader back to the Blackfoot Bridge Environmental Impact Statement (EIS). Although referencing the report is valid, this report should be a stand-alone document, not one that relies on an EIS from another mine site. Please revise the Remedial Investigation (RI) report and for those discussions that refer to the EIS, add the appropriate discussions so that it is unnecessary for the reader to read the EIS or the Ballard RI report.

P4 Response (GC-A)*: This Henry RI Report, much as any other scientific publication relies on previous findings to confirm or further its scientific assumptions/conclusions. The technical documents referenced in the Henry Remedial Investigation Report (Henry RI Report) are included to provide additional relevant technical information from other locations within the P4 property boundaries or Southeastern Idaho Phosphate patch. They are used to support our positions/conclusions based on information collected from other nearby locations where the geology, hydrogeology, environmental setting and conditions, etc. are similar. Where necessary, information from previous studies has been added to the text for clarification.*

A/T Comment: Response OK

B. Overall, contaminants of concern (COC) in groundwater appear to be largely below maximum contaminant levels (MCL) and not migrating offsite. The COC concentrations also appear to be relatively stable, but respond to large snowmelt events (in particular, the above-average snowpack of 2011). However, data gaps in monitoring groundwater are identified in appropriate sections and on the drawings. The report contains numerous speculative statements such as "it is possible" or "probably flows" or "likely" or "either to the northwest or southeast." Statements such as these suggest to reviewers that questions, uncertainties, and data gaps still exist in the site characterization and undermine the conceptual site model (CSM). Revise statements to be more conclusive, or provide additional data or interpretation to eliminate the need for speculation. In addition, several specific comments note potential data gaps with respect to groundwater characterization, and raise questions about the adequacy of the well networks for determining groundwater flow direction and fate of contaminants. In addressing these comments, please identify uncertainties, discuss amount and type of information necessary to support remedial decision making, and identify potential data gaps that must be addressed at the RI stage of the process.

P4 Response (GC-B)*: These statements have been reviewed on a case-by-case basis and revised as needed. Because these are complex natural systems, there will always be some uncertainty. We have attempted to be more definitive and/or qualify the uncertainty where it is possible.*

A/T Comment: Response OK

C. In general, Appendix A of the report is well prepared and is likely to support future remedial decisions. However, it would benefit from revisions to reference the most current U.S. Environmental Protection Agency (EPA) data sources and software. Although risk assessments generally default to protective assumptions to address unknown uncertainties, the toxicity values for arsenic and uranium are notable exceptions. For arsenic, the current cancer slope factor underestimates the risk of internal cancers, but a replacement value is not currently available. For uranium, the recent oral Minimal Risk Level (MRL) prepared by ATSDR is recommended as a superior alternative to the outdated IRIS Reference Dose (RfD) (see attached).

***P4 Response (GC-C)**: The cancer slope factor for arsenic is based on the current EPA value and, because no replacement value is available, this toxicity value was not changed in the revised document. Uncertainty associated with the evaluation of arsenic can be discussed in the uncertainty section of the BRA, as needed, following additional discussion on this topic with the USEPA reviewer.*

The uranium intermediate MRL (ATSDR, 2013) was available at the time the A/T instructed P4 to use the USEPA Office of Groundwater and Drinking Water (OGWDW) (2000) uranium RfD in October 2014. For consistency with prior direction from the A/T on a recommended RfD for uranium, and for consistency with the Ballard Site BRA, the RfD has not been updated.

A/T Comment: Revise to incorporate EPA recommendation to use ATSDR MRL https://semspub.epa.gov/work/HQ/196808.pdf

D. The EPA has recently released the 2016 Aquatic Life Ambient Water Quality Criterion for Selenium in Freshwater. This document provides chronic values for lotic, lentic waterbodies, and selenium in fish tissue whole body and egg/ovary, and reflects the best available science. Although these changes have not been adopted by the State of Idaho, they are Relevant and Appropriate Requirement [ARAR]). Please revise appropriate tables. In addition, EPA recently disapproved the State of Idaho's water quality criterion for Arsenic for the protection of human health. The relevant and appropriate requirement should be revised from 10 to 6.2 ug/l.

***P4 Response (GC-D)**: The text, tables, and drawings have been revised to incorporate the USEPA selenium and arsenic criteria. Please note that the reduction in both criteria will have little to no effect on the drawings and tables (e.g., only at MDS034 will the minimum value now exceed the arsenic criteria on Drawing 4-9). It certainly will not affect the risk assessment or nature and extent of findings as presented in the Henry RI Report.*

A/T Comment: Response OK

E. Volatile organic compounds (VOCs) are not in the list of COPCs for the Henry Mine Site and the human health conceptual site model (Figure 6-1) does not include inhalation as a route of exposure for groundwater. Thus, delete the VOC inhalation concentration column from tables in attachments B, C, D and E of Appendix A, or provide a rationale for using VOC inhalation concentration for groundwater exposure of future residents and future seasonal ranchers in the text and table notes.

***P4 Response (GC-E)**: The VOC concentration and VOC risk columns in the referenced tables are populated with "NA" consistent with the conceptual site model for this Site. However, for clarity, these columns have been removed.*

A/T Comment: Response OK

F. Conclusions of Appendix A, as written, provide a good summary of the Baseline Risk Assessment (BRA). This section would benefit from emphasizing the objectives of the BRA, along with providing concluding statements regarding unacceptable risks associated with specific areas of Henry Mine Site, and major risk drivers for the Human Health Risk Assessment (HHRA), Ecological Risk Assessment (ERA), and Livestock Risk Assessment.

P4 Response (GC-F)*: The BRA conclusions in Appendix A have been revised to restate the objectives of the BRA and identify the most significant risk drivers. A text discussion of specific areas of the Henry Site that are associated with excess risk is beyond the scope of the Henry Site BRA because the risk assessment only evaluated Site-wide EPCs. This request would be more easily accommodated in the FS for the Henry Site that will be prepared following acceptance of this RI document.*

A/T Comment: Response OK

G. Tables in Appendix A have some inconsistencies in the calculations of hazard quotients (HQ) and ecological hazard values. These calculations won't affect the final conclusions of the BRA; however, it would be good to revise all the calculations in the tables for accuracy and consistency in rounding decimals.

P4 Response (GC-G)*: Inconsistencies result from displaying rounded numbers in formatted tables but carrying unrounded values through the calculation to the final HQ. Please refer to responses to SC-119 through SC-122.*

A/T Comment: Response OK

Specific Comments

Report

1. Section ES.4.1; Page ES-4; Paragraph 1 (partial); Sentence 3 (last)

Reword this sentence beginning "Depending on how the site …" as it reads awkwardly.

P4 Response (SC-1)*: The sentence has been revised as follows: "Depending on Site conditions, water can continue downward through the mine dumps and infiltrate into the underlying shallow groundwater. This water then will be present either as seeps or springs further downslope, or as shallow alluvial groundwater plumes downgradient of the mine waste rock source areas."*

A/T Comment: Response OK

2. Section ES.4.1; Page ES-4; Paragraph 2; Sentence 4

Change to "Upland soil collected primarily from the soils developed on the graded and reclaimed waste rock dumps comprises …"

P4 Response (SC-2)*: This edit has been made in the revised report.*

A/T Comment: Response OK

3. Section 1.2.2; Page 1-5; Henry Mining and Reclamation History, second paragraph, 5th sentence

Please clarify, does "As a result, most of the mine pits have been backfilled, graded to promote storm water drainage away from the pit backfill, and were covered and seeded to prevent erosion," mean that the storm water is draining into the pit or away from the pit? What does "away from" mean?

P4 Response (SC-3): *The sentence is intended to mean that storm water drainage is conveyed away from the backfilled and reclaimed mine pits. The sentence has been revised as follows: "As a result, most of the mine pits have been backfilled, graded to promote storm water drainage away from the backfilled mine pits and into intermittent drainages located down slope, then covered and seeded to prevent erosion."*

A/T Comment: Response OK

4. Section 2.5.2; Page 2-10; Vegetation, second bullet

This section describes milk-vetch as a Group 1-primary selenium accumulator species without discussing what Group 1 means, or directing the reader to a table with this information. Please revise for clarification.

P4 Response (SC-4)*: The bullet has been revised to reference NRC, 1983 listed below and the Soil and Vegetation Technical Memorandum (MWH, 2009) for the selenium accumulator species.*

National Academy of Science-National Research Council. 1983. Selenium in nutrition. Rev. ed. Board on Agric. NAS-NRC, Washington, DC.

A/T Comment: Response OK

5. Section 2.5.2, Page 2-10, last bullet

Reference where the list was obtained for which plant species were considered as culturally significant plants during the vegetation sampling/survey.

P4 Response (SC-5)*: The following text has been added to end of the first paragraph in Section 2.5.2: "Culturally significant plant species also were identified as part of the survey. The species list was provided by the A/T and documented in the A/T-approved sampling plan (Culturally Significant Plant Sampling Henry, Ballard, and Enoch Valley Mine Sites Late Summer/Fall 2009 Technical Memorandum [MWH, 2009b])."*

MWH, 2009b. Culturally Significant Plant Sampling Henry, Ballard, and Enoch Valley Mine Sites Late Summer/Fall 2009. Technical Memorandum to Mike Rowe, IDEQ, from Cary Foulk and Randy Walsh, MWH. August.

A/T Comment: Response OK

6. Section 2.6.1; Page 2-11; Regional Hydrogeology

Text states, "The alluvial groundwater typically is *unconfined* by lower permeability layers." Lower permeability layers typically confine groundwater? Check wording and revise if necessary.

> ***P4 Response (SC-6)**: The sentence has been revised to simply say, "The uppermost alluvial groundwater typically is unconfined based on the boreholes and monitoring wells installed at the Site, and therefore, the water table surface and groundwater flow generally mirrors and follows the surface topography".*
>
> **A/T Comment:** Response OK

7. Section 2.6.2.2; Page 2-19; Piezometric and Temperature monitoring

Text states "it is possible there is increased loss from the river to the Wells Formation during high flow events, and this is an area of significant recharge…." This is a potential data gap. To confirm or refute this assertion, streamflow measurements up and down from where the Little Blackfoot River (LBFR) crosses the Wells Formation could be conducted. If the LBFR creates significant recharge to the Wells Formation, and the river becomes impacted by COCs, then this is an important component of the CSM that must be addressed.

> ***P4 Response (SC-7)**: There are several points to consider. First, flow measurements may not have the resolution to see the flow loss, especially during high-flow events because the potential measurement error is often relatively large. Second, COC/COEC concentrations in this area along the LBFR have rarely exceeded screening criteria for either surface water or groundwater. The surface water screening level for selenium has been exceeded at the surface water sampling station MST044, but in only 2 of 14 events did selenium concentrations in the river exceed the surface water screening criteria (0.0031 mg/L), and the groundwater selenium MCL (0.05 mg/L) has never been exceeded in the river. Third, selenium and other COC/COEC concentrations in the river are not trending upward, and there is no reason to suspect they will be given that the Henry Mine is reclaimed and closed over large areas. Finally, the piezometric hydrograph for MMW011, especially in association with high flow events, is indicative of the recharge, and for this reason the sentence in question has been revised to say:*
>
> *"The Little Blackfoot River crosses the Wells Formation near MMW011, and the hydrograph from this monitoring well indicates increased loss from the river to the Wells Formation especially during high flow events. This portion of the river corridor is believed to be an area of recharge to the formation."*
>
> **A/T Comment:** Response OK

8. Section 2.6.2. 2; Page 2-19; Piezometric and Temperature monitoring

a. Text states "MWs MMW011 and MMW023 are on the *conceptual* flow line in the Wells Formation that is *assumed* to terminate at the Henry Springs…" [italics added]. Two wells with 10 feet of water level difference do not necessarily define a groundwater flow direction. An apparent gradient to the north does not mean the groundwater flows north; just that there is a possible northward component of overall flow. Data from nearby mine sites indicates that the gradient and flow direction in the Wells Formation is generally more to the west. Defining the flow direction and gradient in the Wells Formation is an important part of the Site Characterization and CSM. See also 2010 technical memorandum on this topic that was re-circulated recently.

b. Was, or is, the Henry Spring being sampled or monitored? Has the discharge from this spring been chemically "typed" and compared with Wells Formation water? Have site COCs been detected?

Please provide data. If this spring is downgradient from the site and discharges Wells Formation groundwater, data from this spring are important to the CSM and COC Fate and Transport (F&T).

***P4 Response (SC-8)**:*

a) The concept of westward flow in The 2010 A/T technical memorandum (2010 tech memo), was discussed and commented on during the scoping and development of the Final Remedial Investigation/Feasibility Study Work Plans for P4's Ballard, Henry and Enoch Valley Mines (RI/FS Work Plan; MWH, 2011). We also have attached the response to the 2010 A/T Tech Memo that was prepared by Dr. Dale Ralston, P.G., P.E., Professor Emeritus of Hydrogeology, University of Idaho. Dr. Ralston has researched and published many scientific papers on groundwater flow in SE Idaho. The hydrogeologic condition of the regional aquifer also is summarized in Section 5.1.4.3 of this Henry RI Report, and is discussed in more detail in the RI/FS Work Plan, notably Section 3.7.4.3 and associated comments and responses in Appendix F.

As summarized by Dr. Ralston in his response to the A/Ts' 2010 Tech Memo, regional flow patterns cannot be determined based on widely-spaced potentiometric measurements in the structurally and lithologically complex geologic terrain of SE Idaho as suggested by the 2010 A/T Tech Memo (i.e., piezometric measurements separated by major geologic and geographic features cannot be used to project local groundwater flow patterns). The groundwater flow in the regional aquifer at the Site is in Wells Formation (refer to the Drawing 2-2 and Section B-B' geologic map), which is on a steeply dipping limb of a syncline oriented along a northwestern/southeastern line. The groundwater flow relevant to the Site is in poorly cemented sandstone units of the upper Wells Formation. Significant westward flow in the Wells Formation at the Site is very unlikely as this would be across bedding, which would necessitate groundwater movement through lower permeability limestone beds of the Wells Formation. Groundwater flow is similarly restricted in an eastward direction by the low permeability Meade Peak Member of the Phosphoria Formation. Thrust faults to the east and west also bound and compartmentalize the regional groundwater flow system.

Flow to the northwest in the Site area was first put forth in by Dr. Ralston in 1983 (Ralston, et. al., 1983). The presence of the Henry Springs (nearby to the northwest – Drawing 2-1) is strong evidence of northwest flow in the regional aquifer within the hydrogeologic block bounded by the roughly parallel Henry Thrust and the Slug Valley Faults (refer to Drawing 2-2). The Henry Springs are a recognized regional discharge point for the Wells Formation and the regional aquifer (Mayo. 1982; Ralston, et. al. 1983). This northwestern flow direction is further supported by potentiometric measurements collected during the P4 RI from MMW011 and MMW023 that indicate a northwest flow gradient in the uppermost Wells Formation sandstones at the Site (Drawing 2-2 also shows the locations of these monitoring wells). These potentiometric measurements are collected from the upper beds of the Wells Formation on the western syncline limb (i.e., in a continuous hydrostratigraphic unit). Flow to the southeast in the Wells Formation is impeded by the east-west trending Rasmussen Fault (refer to Drawing 2-2) along the southeastern margin of the Site.

Finally, any monitoring well or piezometer installed at a reasonable depth perpendicular to the line between MMW011 and MMW023 would be in steeply dipping hydrogeologic units either up or down the geologic section as shown in Drawing 2-2 and possibly separated by a steeply dipping aquitard, such as the Meade Peak Member of the Phosphoria Formation or lower permeability beds of the Wells Formation. Any piezometric (water level) measurements from these locations would not be indicative of the groundwater flow in the upper sandstone beds of the Wells Formation that are most likely to be affected by the Site.

b) The Henry Springs and the regional aquifer are discussed in Mayo (1982) and Ralston, et. al. (1983). They were not sampled as part of the P4 RI/FS investigations and COC data are not available although general water quality are available in Mayo (1982). However, note that MDW005 is installed in the same area as the Henry Springs and has been sampled for water chemistry and COCs during the P4 RI. Data from MDW005 have been included in the revised Henry RI Report and based on general water quality appears to be similar to the springs. Mayo (1982) dates the water discharging from the springs are in excess of 10,000 years old (i.e., 20,500 years old). However, this is an average age, and discharging spring water may include younger and older contributions. This older date suggests that if any Site water were to have reached the springs, significant dilution and attenuation undoubtedly would have occurred. Any signature or COCs from the Site are not likely to be distinguishable in the discharge because of this dilution (discharge from the springs was approximately 5,000 gpm in 1980 [Ralston et. al., 1983]). The sampling reported in Mayo (1982), and discussed further in Ralston, et. al. (1983), verifies that the water discharging at the Henry Springs is regional aquifer water, of which the Wells Formation is the major component. Other deeper limestone units (Brazer and Madison Limestones) may also contribute some flow. The following discussion has been added to the end of Section 2.6.2.2:

> *"The Henry Springs discharge at an elevation approximately 6,135 feet AMSL, or approximately 20 feet lower than the water level in MMW023. They have formed a large area of travertine located approximately 1 mile west of the northern portion of the Site (Drawing 2-2). The springs and associated flow system were sampled and evaluated by Mayo (1982) and Ralston, et al. (1983). Sampling for the major ions indicate that the water discharging from the springs is a highly evolved calcium-carbonate water type discharging from the Wells Formation. The sulfate content of the springs is low, averaging approximately 50 mg/L. The water discharging from one of the springs was dated at 20,500 years old (Mayo, 1982). The flow volume (> 4,000 gpm), chemistry, and age date indicate this is groundwater discharge from a large portion of the Wells Formation (which represents a large area) and other regional aquifer formations."*

A/T Comment: 1) Thank you for including Dr. Ralston's response to the A/T's 2010 TM on Regional Flow Patterns. As part of his response, Ralston also suggests "Recommended Next Steps". It is assumed that P4 followed-up on these recommendations as a means of completing the hydrogeologic characterization of the Henry Mine site. Please identify where this information resides in the RI, particularly information associated with bullets 3 and 4, which would clarify concerns about flow direction in the Wells formation within the confines of the geologic "compartment" underlying the Henry Mine site.

2) If the Henry Spring is the discharge point for the regional aquifer, and it is downgradient of the Henry Mine, we recommend the spring be sampled to confirm the water type and that water quality is free of COCs and consistent with the last known date of sampling 1982. In active seismic areas, geologic structures dictating the hydrogeology and contaminant fate and transport are known to change over time. The last sampling was 34 years ago. The water quality of Domestic Well MDW005 (sampled 3 times) was offered as a surrogate of water quality in the regional aquifer, but this well is identified in Drawing 3-3 of the RI as a "Local aquifer monitoring well (generally alluvial system)" [total depth of 46 ft]. As such, and given its proximity to the Blackfoot River and Reservoir, it's water quality likely reflects these features as they interact with the local aquifer, whereas the Henry Springs should reflect water quality of the regional aquifer.

9. Section 2.7; Page 2-21; Paragraph 2 (last); Line 7-8

Use of the term leeward is usually associated with wind. Use direction (for example, north and east) or indicate the prevailing wind direction at the site. Please clarify.

***P4 Response (SC-9)**: The sentence has been revised as follows: "Forested land (dominantly conifers) is primarily located near the southern end of the Site."*

A/T Comment: Response OK

10. Section 2.9; Page 2-23; Paragraph 5 (last); Sentence 4

Confirm the date on the establishment of the Fort Hall Reservation, as 1863 would be 5 years prior to the signing of the treaty in 1868.

***P4 Response (SC-10)**: The date has been changed to 1868 in the revised report. Although note there are online references cite the date back to the original 1863 date as provided in the websites below.*

http://www.sbtribes-ewmp.com/land_base_fort_hall.html

http://www.nrcprograms.org/site/PageServer?pagename=airc_res_id_forthall

A/T Comment: Response OK

11. Section 2.10.1; Page 2-24; Phosphoria Formation, first paragraph:

The discussion indicates that there are "naturally elevated background concentrations that result in elevated concentrations of some elements downslope of Meade Peak outcrops in soils and also likely in stream sediment, and possibly downgradient in groundwater and surface water." According to the tables provided in the P4 Background Tech Memo FINAL-Rev 0_March 2013, none of the sediment, surface water or groundwater samples exceeded the screening level for selenium, the site driver. The only elevated selenium samples this reader observed in the background data was for approximately eight soil samples. It appears that the statement made is unsupported by the data, and should be re-phrased to specify which elements you are considering in the statement; bring in the data from the background tech memo for the reader to review.

***P4 Response (SC-11)**: Upland soil background samples initially collected during the RI, as presented in the Background Levels Development Technical Memorandum (2013 Background Levels Tech Memo; MWH, 2013), represent only a portion of the potential area disturbed by the historic mining operations, and did not include soils derived from, and overlying, the Phosphoria Formation. A supplemental soil background study was performed in fall 2014 as detailed in the On-Site and Background Areas Radiological and Soil Investigation Summary Report (2015 Background and Radiological Report, MWH, 2015).*

The 2014 background samples were collected from upland soils overlying the three primary geologic formations including the Phosphoria Formation (Meade Peak and Rex Chert Members) at an undisturbed or natural portion of the Blackfoot Bridge Mine and at Caldwell Canyon. These data were combined with the 2009 upland soil background sampling to develop representative background values for upland soils. The reviewer should become familiar with this study and its findings as the upland soil background concentrations collected in 2014 from the Phosphoria Formation are elevated in several constituents. The resulting 2015 95-95% UTL values for individual COCs/COECs (used for upland soils screening) range from approximately 1.5 to 200 times higher than the 2013 95% USL upland soil background values as shown in the table below.

As noted in the Henry RI Report and the 2015 Background and Radiological Report, representative background samples for sediment, riparian soil/vegetation, surface water, and groundwater have not been collected from native areas downslope/downstream of the Phosphoria Formation. Based on the elevated upland soil constituents detected in 2014, it is plausible that background samples collected downslope/downstream of undisturbed/native pre-mined Phosphoria Formation would result in elevated concentrations in these media as well.

Upland Soil	2013 Background Value (95% USL)	2015 Background Value (95-95 UTL)	Factor Increase
Antimony	0.745	**3.60**	4.8
Arsenic	11.5	**15.6**	1.4
Cadmium	8.6	**41.0**	4.8
Chromium	32.7	**410**	12.5
Copper	37.5	**51.9**	1.4
Molybdenum	3.45	**29.0**	8.4
Nickel	37.8	**220**	5.8
Radium-226	NA	**15.1**	NA
Selenium	1.80	**29.0**	16.1
Thallium	0.288	**1.10**	3.8
Uranium	1.61	**36.0**	22.3
Vanadium	1.61	**300**	185.9
Zinc	173	**1,200**	6.9

A/T Comment: Re-phrase to clarify that statements related to COCs "likely" or "possibly" being elevated in background sediment, groundwater and surface water are hypotheses that have not been tested, and are therefore speculative.

12. Section 2.10.1; Page 2-24; Paragraph 3; Line 4

This sentence implies that all constituents are elevated in soils overlying undisturbed and pre-mined areas of Meade Peak Member. If memory serves, background concentrations at Caldwell Canyon did not differ much from background concentrations observed at other formation/member outcrops (Dinwoody, Wells). Insert a qualifier in this sentence; perhaps, "Please note that for some undisturbed and pre-mined areas …"

***P4 Response (SC-12)**: The sentence was not meant to imply that all constituents are elevated in soil overlying undisturbed and pre-mined areas of the Meade Peak Member. P4 refers the reviewer to Table 3-11 from the 2015 Background and Radiological Report (MWH, 2015), which shows at both Caldwell Canyon and Blackfoot Bridge that a majority of the COCs/COECs including cadmium, chromium, copper, molybdenum, nickel, selenium, thallium, vanadium, uranium, zinc, and radium-226 reported the highest concentrations in the soil samples collected from the Phosphoria Formation (primarily the Meade Peak Member). Based on these 2015 findings, no revision to this sentence is necessary.*

A/T Comment: Response OK

13. Section 2.10.1; Page 2-25; Phosphoria Formation

Rather than referring to another report, please provide a summary table that shows elemental concentrations in the Meade Peak Member to assist in comparisons.

If background concentrations are naturally elevated, please cite the document reporting this information, provide a summary of background concentrations, and identify COCs that are truly elevated as a result of activities at the Henry Mine.

> ***P4 Response (SC-13)****: The report has been revised to include a summary of the elemental concentrations in the Meade Peak Member. This will include a version of Table 2-7 included in the Final Ballard RI Report (November 2014).*
>
> *As discussed in response to SC-11 above, elevated background concentrations in soils overlying the Phosphoria Formation are well documented in the 2015 Background and Radiological Report (MWH, 2015), which is referenced twice in Section 2.10.1. Upland soil background concentrations and a summary of elevated COCs/COECs are provide in Table 4-1, as well as Appendix B Table B-1a, and are discussed in Section 4.1.*
>
> **A/T Comment:** Response OK

14. Section 2.10.2; Page 2-28; Paragraph 1 (partial); Sentence 2 (last)

Explain why data from South Rasmussen Mine (SRM), in particular, will be useful for establishing hydrogeologic characteristics for a location with uncovered center waste shale. The area of study at SRM is a waste rock dump that is covered.

> ***P4 Response (SC-14)****: Note that O'Kane started monitoring an area of uncovered CWS on the Horseshoe Overburden Facility at South Rasmussen in 2008. However, the last paragraph of Section 2.10.2, pages 2-27 and 2-28 has been revised as follows: "In 2007 and 2009, site locations were instrumented with a network of moisture sensors (e.g., time domain reflectometry or TDR sensors) including P4's South Rasmussen Mine. Data from this site and the other sites monitored by O'Kane Consultants (O'Kane, 2009a and 2009b) may be useful in establishing hydrologic characteristics of various cover configurations that occur at the three P4 Sites, including various thicknesses of soil and rock cover."*
>
> **A/T Comment:** Response OK

15. Section 3.5; Page 3-4

There is a potential data gap in surface water sampling locations along the Little Blackfoot River, between MST044 to the confluence with Long Valley Creek/Long Valley Creek Tributary.

> ***P4 Response (SC-15)****: P4 does not believe there is a characterization data gap for surface water along this segment of the Little Blackfoot River (LBFR) because are no sources of P4 contamination that would affect the LBFR downstream of the MST044 monitoring station. Additionally, both monitoring wells MMW011 (Wells Formation) and MMW019 (Alluvial/Phosphoria Formation) located further downstream (i.e., west of MST044) and near the LBFR are not impacted.*
>
> **A/T Comment:** Response OK

16. Section 4.1.3; Page 4-5; Paragraph 3; Sentence 3

Change to "However, as seen on Table 4-1, most of concentrations are within about two times the background level."

> ***P4 Response (SC-16)****: Agreed. The revised RI report contains this change.*
>
> **A/T Comment:** Response OK

17. Section 4.1.4.2; Page 4-7; Paragraph 3; Sentence 4

Delete "with a mean of 4.04pCI/m^2-s," as it is mentioned in the following sentence.

> ***P4 Response (SC-17)****: Agreed. This change has been made in the revised report.*
>
> **A/T Comment:** Response OK

18. Section 4.2.6; Page 4-14; Paragraph 1

If it was "not possible to segregate riparian vegetation results by plant species," how were preliminary COC concentrations in culturally significant riparian vegetation measured? Discuss.

> ***P4 Response (SC-18)****: As discussed in Section 4.2.6, riparian vegetation was sampled and analyzed for a suite of five constituents of concern (i.e., cadmium, copper, molybdenum, selenium, and zinc). The BRA in Appendix A, Sections 3.3.2.1 and 3.3.2.2 states that measured riparian vegetation data were used in the risk assessment calculations for aquatic culturally significant plants, where available. When plant tissue data were unavailable (i.e., not one the five COCs listed above), the plant tissue concentrations of individual constituents (e.g., vanadium) were modeled based on uptake from soil and sediment.*
>
> **A/T Comment:** Response OK

19. Section 4.3.4.1; Page 4-20; Paragraph 4; Sentence 4

The sentence says, "While these concentrations [for sediment] are notable, they have little relevance to the Site as they are not associated with the Site nor were they considered background." Yet, two paragraphs previous for riparian soil, "Because these stations were identified as being associated with the Site and not background locations, they were included in the risk calculations for the Site (see Section 6.0)." Explain this seeming discrepancy.

> ***P4 Response (SC-19)****: As discussed under "Other Stations" in Section 4.3.4.1, "These stations, MST058, MST226 and MST275, were assigned as Site surface water stations, because they are located on tributaries of the Lone Pine Creek drainage, for which, the Henry Site is the dominant feature in the watershed (Drawing 4-8)." They also provide data for conditions in the entirety of Lone Pine Creek including its headwaters (east and west drainages). As a result, these locations were used in the BRA. The sentence initially referred to in this comment has been removed.*
>
> **A/T Comment:** Response OK

20. Section 4.4, Page 4-3, Paragraph 1, Sentence 1

This sentence states that "selenium is the most common contaminant detected at the site." Tables A2-1 through A2-7 show that selenium in not the most common contaminant detected in any medium. The sentence should be revised.

> ***P4 Response (SC-20)**: Note that this sentence is on Page 4-23. It has been revised as follows: "Selenium is the most common contaminant detected above its individual surface water screening criteria."*
>
> **A/T Comment:** Response OK

21. Section 4.4, Page 4-3, Paragraph, Sentence 2

This sentence is not accurate as EPA released new federal water quality criteria for selenium in June 2016 that no longer supports the previous 0.005 milligram per Liter (mg/L) chronic criterion. The current federal water quality criteria (WQC) document recommends water-based lentic and lotic values of 1.5 and 3.1 micrograms per Liter (µg/L), respectively, along with tissue-based. Revisions to the text are necessary to acknowledge the updated federal criteria for selenium.

> ***P4 Response (SC-21)**: See response to GC-D. The document has been revised to reference the updated criteria for selenium.*
>
> **A/T Comment:** Response OK

22. Section 4.4.1; Page 4-23; Preliminary Contaminants of Concern…, last paragraph and page 4-24 first paragraph and elsewhere in the document

Delete the word "slightly" where it describes sampling from the sentences where exceedances are spoken about (and elsewhere in the document) as this term is subjective. A constituent either exceeds or does not exceed screening criteria. Modify as necessary to describe the magnitude of exceedance.

> ***P4 Response (SC-22)**: The word "slightly" has been globally searched and replaced or qualified with an order of magnitude of percentage unit of measure throughout the revised report.*
>
> **A/T Comment:** Response OK

23. Section 4.4.2; Page 4-26; Paragraph 2; Sentence 5

Change: "This pond is typically dry in the fall (Figure 4-7)," to "This pond is typically dry in the fall (note the absence of sampling data in the fall on Figure 4-7)."

> ***P4 Response (SC-23)**: Agreed. This change has been made in the revised report.*
>
> **A/T Comment:** Response OK

24. Section 4.4.3; Page 4-27; Paragraph 3 (last); Sentence 3

Delete "slightly" (too subjective, especially when concentrations are two and three times the criterion) and change to "exceed" (for subject-verb agreement) to read "… MDS016 (0.018 mg/L) exceeds the screening criteria, and two of three samples from MSG002 (0.012 and 0.016 mg/L) exceed the screening criteria."

***P4 Response (SC-24)**: Agreed. The word "slightly" has been replaced in the revised report as noted in the response to SC-22.*

A/T Comment: Response OK

25. Section 4.4.3; Page 4-28; Paragraph 2; Sentence 1

Only one of six concentrations in Table 4-10 for arsenic were reported at the method detection limit (MDL). Revise.

***P4 Response (SC-25)**: Agreed. Section 4.4.3, Page 4-28, Paragraph 2 has been revised as follows: "The measured concentrations of cadmium (key preliminary COC/COEC) in the seeps and spring are typically reported at the MDL (e.g., <0.0001 mg/L) as shown in Table 4-10 with a maximum cadmium concentration of 0.0008 mg/L in MDS016 (spring 2006). Arsenic concentrations ranged from <0.0005 mg/L in MDS022 (spring 2006) to 0.0079 mg/L in MDS034 (spring 2008). These cadmium and arsenic concentrations are below their screening criteria."*

A/T Comment: Response OK

26. Section 4.4.3; Page 4-28; Paragraph 2; Sentence 2

Based on Table 4-10, it looks like the maximum arsenic concentration should be 0.0079 mg/L in MDS034 in Spring 2008. Revise.

***P4 Response (SC-26)**: Agreed. This maximum arsenic concentration has been changed in the revised report. See response to SC-25.*

A/T Comment: Response OK

27. Section 4.4.4.1, Page 4-28, last paragraph, Sentence 3

Dilution is one of several processes for which attenuation may occur. Revise the sentence to read "… through attenuation (e.g, dilution)."

***P4 Response (SC-27)**: Section 4.4.4.1, Page 4-28, last paragraph, Sentence 3, has been revised to read "…. through attenuation (e.g., dilution, sorption, or redox reactions)."*

A/T Comment: Response OK

28. Section 4.4.4.1; Page 4-30; Bullet 3

Shouldn't the value 0.0011 mg/L be included in the MST276 box on Drawing 4-10 where the three samples shown were all nondetects? Revise accordingly.

***P4 Response (SC-28)**: The concentration of 0.0011 mg/L at MST276 was based on a total concentration. For surface water, dissolved concentrations were used for comparison to screening criteria and to develop the summary statistics reported on Drawings 4-9 and 4-10. The exception to this is selenium, where the standard and data are based on total concentration. This will be* *indicated on Drawings 4-9 and 4-10 and noted in the text. The bullets on Page 4-30, Section 4.4.4.1 have been revised to indicate dissolved or total concentrations.*

A/T Comment: Response OK

29. Section 4.4.4.1; Page 4-31; Paragraph 2; Line 1

According to the MST275 box in Drawing 4-10, the minimum should be less than 0.001 mg/L. Revise accordingly.

***P4 Response (SC-29)**: The text is correct. As shown in Appendix B Table B-6b, the lowest detection limit for total selenium at MST275 is 0.0005 mg/L. The minimum value in Drawing 4-10 was incorrectly rounded and has been changed on the drawing in the revised report to 0.0005 mg/L.*

A/T Comment: Response OK

30. Section 4.4.4.1; Page 4-31; Paragraph 2; Line 3

According to the MST275 box in Drawing 4-10 the minimum should be 0.0005 mg/L. Revise accordingly.

***P4 Response (SC-30)**: This change has been made in the revised report.*

A/T Comment: Response OK

31. Section 4.4.4.2; Page 4-32; Little Blackfoot River

Figures 4-10 and 4-11 do not show sampling results for 2011. Was sampling performed in 2011? If so, please include this information. If not, please include a comment as to why sampling was not performed.

***P4 Response (SC-31)**: Sampling was not performed in 2011. A note has been added to Figures 4-10 and 4-11 in the revised report.*

A/T Comment: Response OK

32. Section 4.4.4.2; Page 4-32; Little Blackfoot River

There appears to be a data gap in surface water sampling locations along the Little Blackfoot River, between MST044 to the confluence with Long Valley Creek/Long Valley Creek Tributary.

***P4 Response (SC-32)**: See the response to SC-15.*

A/T Comment: Response OK

33. Section 4.5.2; Page 4-36; Hydrostratigraphy Units

Describe the sampling results of the Monsanto agricultural wells (MAWs) and Monsanto Domestic Wells (MDWs).

***P4 Response (SC-33)**: A summary of the historical ground water COC sampling results has been included in new table in Section 4.5 in the revised draft.*

A/T Comment: Response OK

34. Section 4.5.2; Page 4-36; Paragraph 6 (last); Sentence 1

Where are total dissolved solids (TDS) concentrations shown on Drawing 4-11? Revise accordingly.

***P4 Response (SC-34)**: Reference to TDS has been removed from the sentence.*

A/T Comment: Response OK

35. Section 4.5.2.1; Page 4-38; Shallow Alluvial Unit

a. Does the water in the alluvial aquifer flow downward to lower bedrock units? If alluvial groundwater is or becomes impacted and flows into deeper aquifers, the CSM needs to reflect this possibility. Evaluate vertical groundwater gradients.

b. Text states, "Surface water flow is *presumed* to be directed westward. (1) Should this be "*Groundwater* flow …." (2) Part of site characterization and developing the CSM is to identify the groundwater flow direction; not *presume* where it is directed.

c. From the western mouth of the canyon, the LBFR flows to its confluence with Long Valley Creek and then northwest toward the Blackfoot Reservoir; the site geology map (Drawing 2-2) indicates a ribbon of alluvium. However, no direct push borings or alluvial wells are located along this corridor (Drawing 3-3; 4-11). This is the direction of surface water flow, downgradient of the mine site, and likely shallow groundwater flow in the alluvium, based on the topography. Does shallow groundwater data exist for this area or does this represent a potential data gap?

***P4 Response (SC-35)**:*

a. Vertical gradients were not extensively evaluated during the RI or in this <u>Henry RI Report</u> because of the general lack of alluvial groundwater concentrations exceeding the regulatory screening levels (refer to Drawing 4-11). The most notable exception is the monitoring well MMW010 location. The nearest bedrock well is MPW023 located approximately 750 feet to the southeast in Phosphoria Formation, and COC concentrations do not exceed screening levels in this well. This suggests that downward migration into the bedrock at this location is not occurring despite an apparent slight downward gradient indicated by comparisons of MMW010 and MPW023 water level measurements. Both wells are installed in mining disturbed areas, and adjacent to a backfilled mine pit. This discussion has been added to Section 4.5.2.1 in the MMW010 presentation. **A/T Comment:** Response OK

b. Fundamental to the discussion of flow in the alluvial (including colluvium) system is the recognition that these deposits form a thin veneer of clay, sand and gravel deposited over the bedrock. Where encountered, groundwater is typically between 0 and 20 feet below the ground surface. The relief on the hillsides is on the order of 100's of feet, so in most cases, the water table mirrors the topography. The exception at the Site is along the Little Blackfoot River and upper reaches of Lone Pine Creek that may locally be underlain by thicker alluvium. However, in the upland areas it is the topography and drainage locations that dictate the direction of shallow groundwater flow, which is similar to surface water flow. The sentence in question was rewritten as follows – "<u>Groundwater flow locally, in the thin alluvial deposits, is directed westward toward the Little Blackfoot River following the topography and the local drainage, and</u>

roughly parallels the alignment of the three boreholes in this area." **A/T Comment:** Response OK

c. *Because of the general absence of COC concentrations in surface water or groundwater exceeding groundwater screening levels, downgradient investigation of alluvial groundwater near the confluence of Long Valley Creek was not conducted. This area is approximately 4,000 feet downstream of the Site, and is not considered a data gap. Please see response SC-15 regarding additional surface water investigation in this same area.*

A/T Comment: Response OK

36. Section 4.5.2.1; Page 4-40; Shallow Alluvial Unit

Explain the cadmium results in MMW004 and other wells. Describe the less-than-0.1 (non)detect (above MCL, but below detection limit) (see Drawing 4-11).

***P4 Response (SC-36)**: Cadmium is discussed where it exceeds its screening criteria (i.e., its MCL) which is limited to monitor well MMW010. A single sampling event in October 2005 resulted in a cadmium method detection limit (MDL) above the MCL that affected samples from two wells (MMW004 and MPW022). These wells have several other non-detect results at an MDL below the screening level. This isolated occurrence of a higher MDL does not warrant additional discussion in the text, although, a footnote has been added to the text in this location.*

A/T Comment: Response OK

37. Section 4.5.2.1; Page 4-41; Shallow Alluvial Unit

Text states that alluvium was investigated using "….two monitoring wells." Explain how flow direction is calculated from only two monitoring wells.

***P4 Response (SC-37)**: We are unclear as to where on page 4-41 the comment is referencing. The discussion on page 4-41 primarily addresses analytical results from MMW004 and MMW019.*

Both of these wells lie between waste rock dumps and the Little Blackfoot River, and the purpose of these wells is to sample and analyze the groundwater next to the source areas for contamination. As discussed in response SC-35, it is a reasonable assumption in the alluvial system that groundwater flows from the recharge areas on the hillsides toward topographic low points, in this case the LBFR. That places both wells downgradient of major waste rock deposits (i.e., source areas), which was the objective of the investigation. These wells are on either side of the river, and they are not directly related. In addition, as stated in Section 4.5.2.1, the northern alluvial area was investigated by 14 direct-push boreholes including one that became borehole well MBW152, as well as MMW019 and MMW004. These wells and borings were used to evaluate groundwater flow directions. No revisions to the text are recommended.

A/T Comment: Response OK

38. Section 4.5.2.1; Page 4-42; Shallow Alluvial Unit; Paragraph 5 (last); Line 6

Text states, "This drainage was investigated with three boreholes (BH072, BH076, and BH079)." Should 076 be 078? Revise accordingly.

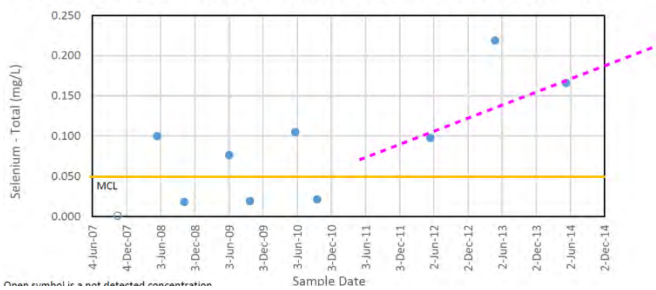
***P4 Response (SC-38)**: The text has been corrected to "(BH072, BH078, and BH079)".*

A/T Comment: Response OK

39. Section 4.5.2.1; Page 4-43; Shallow Alluvial Unit, Figure 4-15

Text states "Selenium concentrations in MMW010 exceed the criteria of 0.05 every spring…and all fall results are below 0.05 mg/L." According to Figure 4-15, no fall samples are available after 2010, and since 2011 the springtime samples have increased and are as high as 0.219 mg/L. Fall samples could very well be above the MCL by now. Either provide fall samples, or modify statement to say that no fall samples have been collected since 2010, and the 2013 and 2014 samples are historic highs.

FIGURE 4-15
TIME SERIES SELENIUM CONCENTRATIONS FOR MONITORING WELL MMW010



***P4 Response (SC-39)**: The sentence has been revised to say, "Selenium concentrations in MMW010 exceed the criteria of 0.05 mg/L every spring with concentrations up to 0.219 mg/L, and all the fall results were below 0.05 mg/L when they measured prior to 2011 (**Figure 4-15**)." P4 does not intend on adding 2015 concentrations to the <u>Henry RI Report</u> (these are reported in the associated 2015 DSR). However, the spring 2015 total selenium concentration in MM010 was 0.119 mg/L (more in line with the pre-2013 concentrations).*

A/T Comment: Response OK

40. Section 4.5.2.2; Page 4-45; Dinwoody Formation

a. Text states "Constituents from the Site could migrate northeastward perpendicular to the syncline axis toward the Henry Thrust Fault, or parallel to the axis of the syncline toward the northwest." The goal of a site characterization/RI is to determine with confidence which way the water flows and thus evaluate where the COCs may migrate – please provide rationale for this statement, or additional discussion.

b. Text states that two monitoring wells were installed to evaluate these flow paths – two monitoring wells do not appear to be adequate to enable characterizing the flow direction and gradient in the Dinwoody formation. Please clarify and resolve.

***P4 Response (SC-40)**:*

a) In the case of the Dinwoody Formation, COCs detected in groundwater contained therein do not exceed their respective screening levels near the source of contamination (where they should be the highest). Therefore, the need for further investigation was dismissed for reasons presented below.

Groundwater collected from monitoring well, MMW022, (installed through the edge of the waste rock dump and into the Dinwoody Formation aquifer), does not exceed screening levels for COCs, and therefore, indicates there is no plume to be evaluated in the area. At the time of the RI groundwater investigation, the concentrations in MMW022 were approximately 0.020 mg/L selenium, below the selenium MCL of 0.050 mg/L. This initially warranted addition investigation, because it indicated a completed flow path (but again not above the selenium or other COC MCLs).

Additional investigation included two activities: 1) installation of a new monitoring well (MMW028) to the northwest along the Dinwoody bedding strike. This location evaluates the most critical pathway because Dinwoody groundwater is moving towards the LBFR, and 2) a survey for springs/seeps in the area to the northeast of MMW022, toward the Henry Thrust Fault. Installation of a monitoring well northeast of MMW022 was not considered necessary because this pathway:

- *Is not as critical for any human/ecological receptors,*
- *Was being investigated indirectly by surveying for seeps/springs,*
- *And any possible locations for a monitoring well along this pathway likely would be on other private property, and construction of an access road would be necessary and difficult in any of the suitable locations to the northeast.*

Groundwater results from samples collected from MMW028 (ranging from 0.00264 – 0.0115 mg/L selenium) indicate that the flow path toward the LBFR is complete, but none of the COCs are detected at levels exceeding groundwater standards (MCLs) along this migration pathway. The spring/seep investigation on the hillside to the northeast of MMW022 indicated no spring discharges. Given the geologic (bedding) configuration of the area, if groundwater flow is northeastward, springs could be expected. The absence of springs suggests the predominant flow direction is not northeastward and toward the Henry Thrust Fault. Since the time of these additional investigations, long term monitoring results of MMW022 indicate that the selenium concentrations have increased, but they do not exceed the selenium MCL. Please refer to SC-49 for additional information on the history of investigation activities related to groundwater contained in the Dinwoody Formation.

The field investigations discussed above (i.e., at and around MMW022) and LTM data have shown us that compared to most areas at the Henry Mine, the area around MMW022 has the potential for producing concentrations that exceed the selenium MCL. The reasons for this are that the physical configuration of the reclaimed area is conducive for higher infiltration through a relatively thin layer of waste rock (thinner waste rock deposits appear to leach more selenium due primarily to less attenuation within the waste rock deposit [Hay, et. al., 2016]). These physical factors will need to be considered when evaluating alternatives for remediation the Site's upland soils/waste rock during the FS.

A/T Comment: Response OK

b) *Regarding the movement of groundwater in the Dinwoody Formation, please refer to comment response SC-8. The issue related to groundwater movement (hydrogeology) in the Dinwoody Formation are similar to the Wells Formation in that groundwater movement tends to be structurally and lithologically controlled in these two formations at the Site. The most probable flow path in the Dinwoody Formation is toward the LBFR (a low point) along the strike of bedding. However, it is acknowledged that flow to the northeast across* *structure toward the Henry Thrust Fault cannot be ruled out, and therefore may be a possibility. Because there is no plume exceeding screening levels in the area, the uncertainty should be acceptable. However, the LTM groundwater results do point to the need for a reduction of precipitation infiltration into the closed basin created by the waste rock in the MMW022 area. Future source controls selected during the FS in this location might include increasing the thickness of the ET cover or regrading and diverting stormwater away from the area, etc., which would reduce the potential for further contamination of the underlying Dinwoody Formation groundwater.*

Given the discussions above, there is more certainty than indicated in this Henry RI Report in regard to the northwest flow direction. Therefore, the second sentence of the introductory paragraph of Section 4.5.2.2 has been revised to say:

> *"This location is in the recharge zone for the Dinwoody Formation; constituents from the Site are migrating parallel along the axis of the syncline toward the northwest and the Little Blackfoot River. However, some migration to the northeast toward the Henry Thrust Fault, perpendicular to the syncline axis also is possible (refer to Section 2.6 for further hydrogeology discussion)."*

As discussed above, the basis for this statement is the CSM and the results from MMW028 that indicate some COC migration to that location.

A/T Comment: Response OK

41. Section 4.5.2.2; Page 4-45; Dinwoody Formation

Regarding the elevated selenium concentrations in MMW022 after the "large recharge event of 2011" and that the elevated concentrations are an advancing pulse from an "uncommon" recharge event, as opposed to an advancing plume - following text states that concentrations should decrease in future sampling rounds "*assuming additional anomalous recharge events do not occur.*" It cannot be predicted if, and when, another uncommon or anomalous recharge event will occur. This reasoning appears flawed; please revise.

P4 Response (SC-41)*: Agreed. There will be future high recharge events, and the discussion does not reflect the issue correctly. The issue is not whether a high recharge event will occur in the future (they will), but if there are consecutive events, which might not allow the pulse from an individual event to dissipate. The sentence has been revised to say, "Therefore, the elevated concentrations appear to be related to the uncommon recharge event (an advancing pulse) as opposed to an advancing plume. If the former is the case, then concentrations should decrease in future sampling rounds as the pulse migrates and dissipates and/or attenuates as it moves downgradient (i.e., assuming consecutive or closely spaced anomalously high recharge events do not occur)."*

A/T Comment: Response OK

42. Section 4.5.2.3; Page 4-46; Wells Formation

Text states "flow direction in the Wells Formation at the site is *predicted* to be to the northwest toward the springs…" See previous comment (#35) – the flow direction in the Wells Formation aquifer is important for determination of the fate and transport of COCs. Typically, flow direction in the area is more to west; flow direction should be confirmed by site data. Please clarify and resolve.

***P4 Response (SC-42)**: Please see the response to SC-8.*

A/T Comment: Response OK

43. Section 4.5.2.3; Page 4-48; Paragraph 1; Sentence 2

If all but one selenium concentration was a non-detect, then all but one concentration represented in Figures 4-19 and 4-20 should be open symbols. Revise accordingly.

***P4 Response (SC-43)**: The sentence is incorrect. The concentrations on Figures 4-19 and 4-20 are correct, and the sentence has been revised as follows: "With one exception (i.e., concentration of 0.017 mg/L in MMW023), selenium concentrations in both monitoring wells are below 0.004 mg/L."*

A/T Comment: Response OK

44. Section 4.5.2.4; Page 4-49; Other Hydrostratigraphic Units

Text describes how the wells are likely downgradient of the mine pit and upgradient of the Lone Pine creek. Provide more data to substantiate this assertion. Show this on the cross section to illustrate the argument.

***P4 Response (SC-44)**: Well MPW022 has been projected into Drawing 5-3 showing the relationship between this well and the Lone Pine Creek alluvial system. Conditions at MPW023 are similar, but with slightly flatter gradients. A reference to Drawing 5-3 has been added to the text.*

A/T Comment: Response OK

45. Section 4.5.3; Page 4-51; Water Quality Typing

Text states "were [sic] oxidizing sulfides are a source of selenium." (a) Change "were" to "where" and (b) Are the oxidizing sulfides the actual source of selenium, or do they merely increase the mobility? This statement is not clear – the middle waste shale is typically identified as the source of selenium. Please clarify the statement.

***P4 Response (SC-45)**: a) The typo was corrected. b) The sentence in question read, "This is consistent with the conceptual geochemical model, discussed in detail in the <u>RI/FS Work Plan</u>, were oxidizing sulfides are a source of selenium". To address the comment, the sentence has been revised to say, "<u>This is consistent with the conceptual geochemical model, discussed in detail in the RI/FS Work Plan, where oxidizing sulfides in the waste shales are a source of selenium</u>". (The center waste shale [CWS] is a major source of selenium, but other beds in the Meade Peak Member may also contribute.)*

However, please note that in context, the statement questioned is explaining the relationship between sulfate and selenium. The geochemical reservoirs of selenium include, readily soluble selenium compounds, sulfides, and some organically bound selenium. In the Idaho phosphate mines, the soluble selenium compounds typically are identified as the dominant source of selenium to the environment. However, most of this soluble selenium is chemically associated with sulfide weathering (oxidation) that occurred in situ prior to mining. It has been shown that sulfides are the main reservoir of selenium in <u>unweathered</u> CWS (Perkins and Foster, 2004). The sulfides also are the *source of sulfate upon oxidation. Weathering has occurred over geologic time to produce the soluble selenium and sulfate minerals that may be dissolved and be released upon mining. Some amount of oxidation also may occur post-mining depending on specific conditions. Regardless of when the oxidation occurred, because of the chemical relationship, the selenium-sulfate correlation has remained.*

In regard to the portion of the comment related to increased mobility, because of the inherent net neutralization potential of the Phosphoria Formation rocks, pervasive acidic conditions do not develop. Therefore, sulfide oxidation can lead to release of selenium bound in sulfides more so than acid leaching of other minerals and organics that contain selenium.

A/T Comment: Response OK

46. Section 4.5.5; Page 4-53; Aquifer Solids

Text states, "*It is possible* that at this location the alluvium was derived largely from the Meade Peak Member outcrop." Please review drilling logs to evaluate whether information is available to address this question of interest. It should be obvious if the alluvium is derived from the Meade Peak formation. For future characterization activities, the onsite geologist should carefully log the borings and evaluate the provenance of the alluvium to accurately characterize the site. During future investigations, please provide detailed logging and observations of drill cuttings and lithologic samples.

P4 Response (SC-46)*: It is incorrect to assume that, "it should be obvious if the alluvium is derived from the Meade Peak Formation". The alluvium is dominated by brown clays, silt and sand with some gravel (RI/FS Work Plan, see direct push and well logs). Based on the lithological composition of the geologic units at the Site, the clay and silt largely originates from the Phosphoria, including the Meade Peak Member, or Dinwoody Formations, and much of the sand is likely from the Wells Formation. However, the Meade Peak Member clay does not retain its dark color upon weathering and is not likely visually distinguishable from clays derived from the Dinwoody Formation or Cherty Shale Member (Phosphoria Formation) as an example. No study has been conducted to confirm this, but it is based on field observations including during drilling. Weathered Meade Peak Member rock locally is called brown shale, and it is the source of the Henry Mine cover material. The best way to distinguish the origin of these different clay types is geochemically, because visual confirmation is not possible. Identification of larger rock fragments in the colluvial soils could help identify the source of the material, but the origin of the clays and large rock fragments may be from separate sources.*

All borings were logged by an on-site geologist/hydrogeologist, and the logs are provided in the RI/FS Work Plan or in subsequent RI Data Summary Reports (DSRs). Because the logs have been submitted to the A/Ts, we are not resubmitting these data at this time. However, the RI/FS WP and other DSRs should be available to this reviewer, and if not, can be provided electronically.

A/T Comment: Response OK

47. Section 5.1.4; Page 5-7; Groundwater Pathways

Text states "This resulted in validation of potential pathways and identification of those pathways requiring further investigating." Has further investigation been conducted, and if so, what are the results?

P4 Response (SC-47)*: The sentence in question is contained in a paragraph describing the overall approach to the groundwater investigation. Further investigation was conducted as part of the RI process, and these data are reported in this Henry RI Report. For example, there were two rounds of direct-push investigation. The second round was conducted to address data gaps identified following the conclusion of the first round. Monitoring well MMW028 was installed in response to the results from MMW022. The sentence has been modified to say, "This resulted in validation of potential pathways and identification of those pathways requiring further investigation during the RI."*

A/T Comment: Response OK

48. Section 5.1.4; Page 5-7; Groundwater Pathways

Text states, "Deeper groundwater flows generally along bedrock bedding is either to the northwest or southeast." This statement is confusing as written and suggests a lack of site knowledge. Revise.

P4 Response (SC-48)*: The sentence highlighted is contained in an introductory paragraph and is followed by "The details of the groundwater contaminant transport pathways for each of the flow systems are presented in the following subsections." Therefore, the uncertainty is addressed in the following sections. However, the conclusion is that evidence indicates that bedrock groundwater flow is dominantly to the northwest, and the sentence has been revised as follows: "Deeper groundwater flows generally along bedrock bedding, primarily to the northwest toward the Henry Springs discharge area."*

A/T Comment: Response OK

49. Section 5.1.4.2; Page 5-9; Dinwoody Formation

This section describes flowpaths from waste dumps into the Dinwoody and general groundwater flow in the Dinwoody Formation. Text states "Contaminated external waste rock dump seepage entering the Dinwoody Formation…..forms complete flow paths." In nearby sites, elevated COCs in the Dinwoody Formation are observed where waste rock dumps directly overlie this unit (for example, elevated COCs are found where MWD086 overlies the Dinwoody and MMW022). Another example where this could occur at the Henry Mine is where MMW085 overlies the Dinwoody Formation (Drawings 2-2 and 5-2 [Section P-P']. No monitoring well is installed to monitor this portion of the Dinwoody Formation (Trd) and is considered a data gap**.** See General Comment B for direction.

P4 Response (SC-49)*: As presented in the RI/FS Work Plan, the approach was not to investigate every location of possible COC impacts over the large area represented by the Site. The RI objective was to investigate various locations with specific conceptual flowpath configurations that appeared to have the highest probabilities of COC impacts to Site groundwater. In the case of the Dinwoody Formation, the MMW022 location was investigated, and based on field observations and groundwater results from that installation, MMW028 was installed. The MWD085 and MWD086 locations were not considered a large concern as drainage and slopes were more favorable for reducing infiltration.*

The MMW022 location was selected because there is a large area of waste rock overlying the Dinwoody Formation in this area, and the reclamation grading forms a localized closed basin (i.e., surface water must infiltrate because there is no outlet for runoff). Additionally this location is on the possible flow path along the Dinwoody Formation strike, which is towards the LBFR. MMW028 was installed further to the northwest (again along strike) the next year, after elevated concentrations of *selenium were detected in MMW022, to address the most critical possible flow path along strike towards the LBFR (refer to Drawing 2-2 for the locations of these wells).*

Based on the conceptual Site model and flow path associated with MMW022, no further investigation of the "waste rock – Dinwoody on-lap" was conducted. This was largely because the MMW022 location represents a "worst case" position along the flowpath, but has not exceeded COC screening levels (the sulfate screening level has been exceeded, but it is not a COC).

One point of further clarification needs to be made. These Dinwoody monitoring wells (i.e., MMW022 and 028) were installed and sampled prior to development of the RI/FS Work Plan. The groundwater results from these wells were considered in scoping the RI/FS Work Plan and the A/T concurred with the Dinwoody Formation investigation approach that included no additional Dinwoody Formation monitoring wells (i.e., it was determined that there was not a data gap).

A/T Comment: Response OK

50. Section 5.1.4.3, Page 5-9; Wells Formation Groundwater System

As noted, the Wells Formation is considered a host of regional and/or intermediate groundwater systems. The report provides a compelling argument that the Wells Formation groundwater is fault-controlled and that, "these Faults appear affecting and focusing regionals groundwater transport and discharge" and that "This flow direction is supported by site data, specifically the piezometric levels in monitoring wells MMW011 and MMW023."

a. The wells Formation is interrupted by folding and faulting throughout the region. However, regional data indicate that despite the structural controls, the Wells Formation aquifer exhibits a relatively uniform groundwater elevation and gradient, with flow generally to the west. Two monitoring wells located in the northern part of the site do not necessarily provide the required data to evaluate site-wide flow directions and gradients. This is a potential data gap. Please include regional data from other mine sites (e.g. data from 2010 Technical Memorandum – Groundwater Flow in the Wells Formation), or other wells constructed in the Wells Formation to enhance the discussion and support assertions (in addition to the two observed piezometric levels on site). See General Comment B for direction.

b. No monitoring wells have been constructed south of the LBFR so, despite open and backfilled mine pits and large areas of Wells Formation outcrop, the entire southern two-thirds of the site has no groundwater data for Wells Formation. For example, Drawing 5-3 (Cross Section N-N') shows an idealized scenario where a backfilled/open mine pit with a pond (MSP055, which contains elevated cadmium, nickel, selenium, and zinc that exceed surface water and groundwater screening levels) could recharge directly into the Wells Formation and introduce COCs. This is considered a data gap. See previous comment, and also General Comment B for direction.

***P4 Response (SC-50)**:*

a) Please see the response to Comment 8 (SC-8). Data from mines miles away do not provide any insight into groundwater flow at the Site.

b) Several discussion points should be considered in response to this question. First, pond MSP055 is a seasonal pond located on the mine pit floor, which primarily overlies the Meade Peak Member (CWS, etc.). However, it does abut the Wells Formation-Meade Peak Member contact. Second, the water table was quite high in this area of the mine as indicated by P4's installation of dewatering wells MPW022 and MPW023. The elevated water table in this area further supports the northwest *flow component at the Site, making MMW011 downgradient. Third, the flow path is contained within the Site and is monitored by two downgradient monitoring wells – MMW011 and MW023.*

P4 does not agree that there is a data gap as Wells Formation groundwater flow in this area is restricted to the northwest and into the core of the Site as discussed in Response SC-8. Because of surface water risks, MSP055 will be addressed in the FS. Remedial action (RA) solutions for this location should be relatively straightforward (e.g., lined surface water collection and retention systems; backfill, grading and applied cover system over portions of the pond area; and/or run on/run off controls), and the RA construction work can address both the surface water and possible groundwater issues based on the FS evaluations.

A/T Comment: Response OK

51. Section 5.1.4.4; Page 5-11; Structural Flow System

The second paragraph describes a potential east-west trending structure located between MMP-041 and MMP043, and the third paragraph describe other smaller faults in the site vicinity. The report concludes that these potential structures would not likely affect groundwater flow. The reviewer would like to acknowledge that he appreciates the extra effort put into the site investigation to look further than existing data points to identify previously unknown structures and evaluate their potential to influence COC fate and transport. Nice job.

***P4 Response (SC-51)**: Thank you. As noted in SC-8, groundwater flow in the Wells Formation is strongly influenced by the location and orientation of the Wells Formation (i.e., the local geology including the structural geology component), in particular, the sandstone beds in the upper portion of the unit. Any disruption in the continuity of the unit would be significant for the CSM, and therefore, had to be evaluated.*

A/T Comment: Response OK

52. Section 5.3.3; Page 5-18; Surface Water

The text states that COCs do not make it to LBFR via Lone Pine Creek and that the most downstream affected station is MST057. Suggest adding that MST056 is non-detect and therefore delineates the downstream extent of COCs in Lone Pine Creek.

***P4 Response (SC-52)**: Agreed. The text has been revised to state that concentrations of all COC/COECs are below surface water screening criteria at MST056, which therefore delineates the downstream extent of elevated COCs/COECs in Lone Pine Creek.*

A/T Comment: Response OK

53. Section 5.3.3, Page 5-18, Paragraph 2, Sentence 3

Dilution is one of several processes through which attenuation may occur. Revise the sentence to read "Through attenuation (e.g, dilution)…"

The second part of this sentence "…concentrations of contaminants…" should be revised to read "…elevated concentrations of contaminants…"

***P4 Response (SC-53)**: Agreed. The first part of the sentence has been revised to read "…. through attenuation (e.g., dilution, sorption, or redox reactions)". The second part has been revised as suggested.*

A/T Comment: Response OK

54. Section 5.3.4; Page 5-20; Groundwater

The text states "The southeast portion of waste rock dump MWD085 is adjacent to and overlies the basalt (Drawing 2-2). Therefore seepage or infiltration from MWD085 may recharge and could cause impacts to groundwater within the basalt." Based on Drawings 2-2 and 5-2 (Cross Section P-P'), MWD085 overlies the Dinwoody and upper Meade Peak (Rex Chert/Cherty Shale) formations, but does not directly overlie basalt. Please revisit and revise this discussion to be more accurate. In addition, no data are available to evaluate the potential impacts to the Dinwoody Formation beneath MWD085; and is thus considered a data gap. See General Comment B for direction.

***P4 Response (SC-54)**: The comment is correct; the waste rock is not mapped as directly overlaying the basalt. However, a flow path still exists via the alluvium that tends to pinch out on the basalt. The sentence in question has been revised to say, "The southeast portion of waste rock dump MWD085 is adjacent to the basalt (Drawing 2-2). Therefore, seepage or infiltration from MWD085 into the alluvium could flow downhill, infiltrate the basalt and could cause impacts to groundwater within the basalt."*

Based on the Dinwoody investigation adjacent to MWD086 and MWD088 (MMW022 and MMW028), it was determined that investigation of Dinwoody Formation below MWD085 was not necessary. P4 does not consider this a data gap. See response SC-49 for additional discussion.

A/T Comment: Response OK

55. Section 5.3.4.1, Page 5-23; Alluvial System

Text states "Groundwater samples collected further downgradient at BH169 (0.016 mg/L)…" Double-check this value; it should be 0.0016 mg/L.

***P4 Response (SC-55)**: This value has been corrected in the revised Henry RI Report text (as provided in your comment – 0.0016 mg/L).*

A/T Comment: Response OK

56. Section 5.3.4.2; Page 5-24; Dinwoody Formation

The text describes:

- the interaction between waste rock dumps and the Dinwoody Formation, where the lack of alluvial material allows direct infiltration into the Trd;
- how MMW022 was installed as a "worst case" scenario to evaluate COC loading in the Trd; and
- how MMW022 shows elevated COCs (near the MCL for selenium) that are related to the large recharge of 2011.

This discussion reinforces the need for a monitoring well in the Dinwoody underneath MWD085, which is in direct contact with the Dinwoody (outcrops of Dinwoody are clearly evident adjacent to this waste rock pile). This appears to be an idealized situation to contribute elevated COCs into the Dinwoody and reduce its potential as a beneficial use aquifer. See also Specific Comment 55.

P4 Response (SC-56)*: Please see responses to SC-49 and SC-54.*

A/T Comment: Response OK

57. Section 5.3.4.3; Page 5-26; Wells Formation

The text attributes low concentrations of COCs in the Wells Formation to a lack of selenium mobility in reducing conditions and reducing flowpaths, among other reasons. However, no monitoring well is constructed in the Wells Formation beneath pond MSP055, which contains some of the highest COC concentrations at the site and sits directly on Wells Formation exposed in the mine's footwall. Clarify how this determination was made.

P4 Response (SC-57)*: See response to SC-50.*

A/T Comment: Response OK

58. Section 5.3.4.4; Page 5-26; Migration Summary in Site Groundwater Systems

The text states, with respect to the Dinwoody Formation, that "concentrations in the unit increase with increased winter precipitation and snowmelt. However, to date screening criteria have not been exceeded in this unit." Note that in MMW022, the average sulfate concentration exceeds the screening level, and selenium is very close to the MCL. It is possible that future large precipitation events could push the selenium level higher. Revisit and revise narrative.

P4 Response (SC-58)*: The text has been revised to be consistent with response SC-41. The bullet now reads, "The conceptual model of contaminant transport into the Dinwoody Formation groundwater on the northeastern edge of the Site appears to be validated, and concentrations in the unit increase with increased winter precipitation and snowmelt. However, to date screening criteria have not been exceeded in the unit with the exception of sulfate, which is not a COC based on its screening criteria (i.e., secondary MCL) not being an ARAR. It is possible that future selenium concentrations could exceed screening levels as the result of sequential or closely spaced above average precipitation years."*

A/T Comment: Response OK

59. Section 6.1, Page 6-3, Paragraph 2, Sentence 3

Remove the two occurrences of "incremental" from the sentence. Using "incremental ILCR" is duplicative since ILCR is an acronym for incremental lifetime cancer risk.

P4 Response (SC-59)*: Please note that the "I" for incremental in "ILCR" indicates that the cancer risk presented is the increase in cancer risk above the incidence of cancer in the general population (about one in three). In contrast, the "incremental" in "incremental ILCR," as defined in the first sentence of the referenced paragraph, refers to the increase in cancer risk associated with historic* *activities at the Site above the cancer risk associated with constituents present at regional background or ambient concentrations.*

The first two sentences of the referenced paragraph state: "The Tier II HHRA also includes the calculation of RME-based incremental risk estimates, defined as the COPC-specific difference between the risk estimates for Site and background sample locations. COPC-specific incremental ILCR and HQ estimates are summed to cumulative incremental ILCRs and HIs for each medium and receptor." As described above, the first sentence defines incremental ILCR estimates and the incremental HQ estimates presented in the BRA for the Henry Site as the ILCR/HQ estimates calculated from concentrations of COPCs measured in media at Henry Site sample locations minus the ILCR/HQ estimates calculated from concentrations of COPCs measured in media at background sample locations. To clarify this point, the first two sentences of the referenced paragraph have been revised as follows: "The Tier II HHRA also includes the calculation of RME-based incremental ~~risk~~ ILCR and HQ estimates, defined as the COPC-specific difference between the ~~risk~~ ILCR and HQ estimates for the Site and the ILCR and HQ estimates for background sample locations. COPC-specific incremental ILCR and incremental HQ estimates are summed to cumulative incremental ILCRs and incremental HIs for each medium and receptor." Additionally, the final sentence of the third paragraph of 6.1, on page 6-2, has been revised as follows: "For each receptor evaluated, incremental lifetime cancer risks (ILCRs), defined as the incremental increase in cancer risk above the incidence of cancer in the general population, and noncancer hazard quotients (HQs), defined as the ratio of exposure to a noncarcinogenic constituent and the exposure level for that constituent at which no adverse effects are expected, are calculated for individual chemicals.~~; and~~ Subsequently, cumulative ILCR and cumulative HQs, or hazard indices (HIs), are calculated for all chemicals over all applicable exposure media.

Section 3.3.4 of Appendix A has also been revised to clarify the definitions of ILCR, HQ, incremental ILCR, and incremental HI.

A/T Comment: Response OK

60. Section 6.4, Page 6-6, bullets.

Revised the introductory sentence for the bullets to say, "… are generally interpreted as follows:" Also, the second and third bullets are confusing as written. The second bullet indicates that exposures above the no observed adverse effect level (NOAEL), but below the lowest observed adverse effect level (LOAEL), may pose an unacceptable risk to individuals; the third bullet indicates exposures above the LOAEL may pose an unacceptable risk without clarifying whether this is for individuals, populations, or both. Add clarifying language to these bullets.

***P4 Response (SC-60)**: "Generally" has been added to the introductory sentence for these bullets, and the third bullet has been revised to indicate that a LOAEL-based HQ greater than 1 indicates that adverse effects may occur to populations of ecological receptors in Section 6.4 the RI, and in Sections 4.2.4 and 5.2.4 of Appendix A. Additionally, "may occur to individual receptors" has been added to the second bullet in Sections 4.2.4 and 5.2.4 of Appendix A.*

A/T Comment: Response OK

61. Section 6.6.2; Page 6-12; Paragraph 5; Sentence 2

Stick to talking about the long-tailed vole and save discussion on the deer mouse for its own section. Revise accordingly.

P4 Response (SC-61): *The deer mouse was referenced in the text for the long-tailed vole in order to support elimination of antimony from further evaluation as a risk driver in upland soil/waste rock. However, conclusions regarding risk drivers for individual media are more appropriately described in Section 6.9.4. Therefore, the discussion of ecological hazard associated with antimony in upland soil/waste rock has been moved to Section 6.9.4. Similarly, as indicated in the response to SC-98, the comparison of Henry Site and background hazard estimates for the mink has been moved to the risk summary in Section 6.9.4.*

In Appendix A, the Tier II ecological hazard estimates presented in Section 4.3.2 include the same evaluations of hazard estimates associated with Site media relative to hazard estimates for background media under receptor-specific headings. These discussions have been moved to a new Section 4.3.3.

A/T Comment: Response OK

62. Section 6.6.2; Page 6-13; Paragraph 4; Sentence 2

Stick to talking about the deer mouse and save discussion on the long-tailed vole for its own section. Revise accordingly.

P4 Response (SC-62): *Please refer to the response to SC-61.*

A/T Comment: Response OK

Tables

63. Include a table that provides a summary of COC concentrations in monitoring wells.

P4 Response (SC-63): *A new table has been referenced in Section 4.5, which provides a summary of COC concentrations in the monitoring wells.*

A/T Comment: Response OK

64. Table 4-5. The highlighting for the seventh note listed should be removed.

P4 Response (SC-64): *This change has been made in the revised report.*

A/T Comment: Response OK

65. Table 4-11. Describe whether these metals concentrations are for total or filtered analytical results. Considering these are for comparisons with MCLs or state groundwater standards, the appropriate comparison should be with total metals concentrations.

P4 Response (SC-65): *The metals concentrations in Table 4-11 are for total analytical results. A note has been added to Table 4-11 indicating that concentrations in the table are for unfiltered (total) groundwater metals results.*

A/T Comment: Response OK

66. Table 4-14. There are a number of values listed as 0.000 or 0.0. Revise the table to show the correct significant figures.

P4 Response (SC-66)*: The table has been revised to show the correct significant figures.*

A/T Comment: Response OK

67. Table 4-16. A note should be added that describes what the highlighted values in the table mean.

P4 Response (SC-67)*: A note has been added that states "highlighted values indicate stations where fish were observed."*

A/T Comment: Response OK

68. Table 6-16. EPA released new federal water quality criteria for selenium in June 2016 that no longer supports the previous 0.005 mg/L chronic criterion. The current federal WQC document recommends water-based lentic and lotic values of 1.5 and 3.1 µg/L, respectively, along with tissue-based. Revisions to the table are necessary to acknowledge the updated federal criteria for selenium.

P4 Response (SC-68)*: See response to GC-D.*

A/T Comment: Response OK

69. Table 6-16. This table indicates that site-wide surface water exposure point concentrations (EPC) were used to evaluate risk to aquatic organisms. This may be appropriate for some upper trophic level receptor's exposure; however, amphibians, fish, and invertebrates will be exposed within a singular waterbody. The risk screening needs to be revised to be representative of the exposures to which aquatic organisms within specific waterways will be exposed.

P4 Response (SC-69)*: Agreed. Although some ephemeral surface water stations are likely too small to support aquatic life, Site-wide EPCs in Table 6-16 (and in Table A4-21) have been replaced by the Site-wide maximum detected concentration to identify risk drivers. A waterbody-specific evaluation was not done in Section 6.0; such an evaluation would be redundant with Section 4.4 and Drawings 4-9 and 4-10 in this RI, which compare waterbody-specific concentrations to screening criteria.*

A/T Comment: Response OK

Drawings

70. The geologic cross sections illustrate a dearth of groundwater monitoring wells, resulting in suspected/inferred groundwater elevations and flow directions. For example, sections B-B' and P-P' only have one monitoring well, and the others only show two monitoring wells. If possible, add more data to the cross sections, such as projecting other wells and sample results to form a more complete picture of the CSM and COC Fate and Transport.

P4 Response (SC-70)*: Because of the size of the Site, the data points are spaced at considerable distances from each other. It is possible to bring these points together in the direction of a cross* *section, but bringing them in from the lateral distances involved does not provide a representative (or clearer) picture. Surficial geology including contacts, strike and dip of bedding, and structures has to be utilized. This is why the sections are indicated as "schematic" and are used to convey concepts. We have added MPW022 to Drawing 5-3.*

A/T Comment: Response OK

71. Drawing 2-2

Change the symbol for MMW019 to represent a local aquifer monitoring well.

Change the symbol for MMW004 to represent a local aquifer monitoring well.

P4 Response (SC-71)*: MMW019 symbol has been revised to a local aquifer monitoring well. As shown on Table 3-5, the screened interval is unknown for MMW004. It can be assumed based on the location and depth of this well that is screened in the local aquifer, but this cannot be confirmed. For this reason, the symbol for MMW004 has not been revised.*

A/T Comment: Response OK

72. Drawing 2-3

Show the groundwater elevation in the Wells Formation.

The schematic groundwater flow vector in the Wells Formation' indicates downward flow, but text describes flow to the north. Is there a downward component of flow? If so, provide data to support this assertion. Similar comment for the Dinwoody Formation flow vectors – text (and Figure 5-3) describes possible flow to north along the axis of syncline, not eastward

The selenium concentration of 0.017 mg/L in MMW022 is from 2008. Yet the selenium concentration was approximately 0.045 mg/L in 2014. It is unclear why this drawing presents an older, lower concentration of selenium. Either provide justification for this, or update with the more recent concentration.

P4 Response (SC-72)*: Because the dominant flow directions in both the Dinwoody and Wells Formations are perpendicular to the section, the flow arrows are confusing. The drawing has been revised to help clarify the relevant flow patterns. Please note that the downward flow arrow on the Wells Formation indicates flow along bedding to the groundwater table where flow is then to the northwest. Addition of an inferred potentiometric surface will help depict that flow path.*

The purpose of presenting the concentrations was to illustrate a uniform picture of the Site at one time as possible, not to present maximum concentration regardless of when they occurred. Data from 2008 was selected based on when the drawings were originally developed and the completeness of the data set. A note has been added to the drawings to indicate sampling dates and reference Appendix B for a complete table of historical results.

A/T Comment: Response OK – However, for the record, it might be considered misleading to present older, lower COC concentrations when more recent monitoring indicated higher concentrations.

73. Drawing 3-3

Change the symbols for agricultural wells MAW004, 006 and 007 to represent agricultural wells.

Change the symbols for domestic well MDW0001 to represent a domestic well.

> ***P4 Response (SC-73)****: The symbols on Drawing 3-3 for monitoring wells as well as agricultural and domestic wells indicate the screened geologic unit based on drilling logs. For example, MDW001 is screened in the local aquifer, and MAW006 is screened in the Dinwoody Formation. A general symbol is used for wells when the screen interval is unknown or if the well is screened over multiple aquifer. An acronym list of well descriptors (e.g., MAW – agricultural well) has been added to Drawings 3-3 and 4-11.*
>
> **A/T Comment:** Response OK

74. Drawing 4-11

Show interpreted flow directions for alluvial and bedrock groundwater flow systems.

For direct-push boreholes (BH) that exceed the selenium MCL, highlight or bold to demonstrate exceedances; alternately, shade the general impacted area.

Expand this drawing to the northwest to show the location of Henry Springs, and include sample results for Henry Springs (as this spring is described as a discharge for the Wells Formation).

Show other sample results (for example, results of MAW004, 006, and 007). These agricultural wells would appear to be important potential receptors.

MDW001 is shown, but no sample results are shown; according to Table 3-4, this well is not part of the sampling protocol. Add wells MDW003, MAW003, and MDW005 and include any sampling results.

> ***P4 Response (SC-74)****: The suggested changes have been made with the exception of showing data for the Henry Springs (see response to SC-8).*
>
> **A/T Comment:** Response OK

75. Drawing 5-2

Based on this cross section, the Dinwoody Formation below MWD085 would be a very good placement for a monitoring well to evaluate COC migration from the waste rock into this aquifer.

Show the groundwater flow direction in the Wells Formation.

> ***P4 Response (SC-75)****: Regarding the Dinwoody, please see responses SC-49 and SC-54. A note has been added to the drawing indicating that groundwater flow in the Wells Formation is into the drawing to the northwest.*
>
> **A/T Comment:** Response OK

76. Drawing 5-3

Show the groundwater elevation and flow directions in the Wells Formation.

Add MPW022 and sample results.

Add MSP055 and sample results.

P4 Response (SC-76)*: The suggested edits/additions have been incorporated into Drawing 5-3.*

A/T Comment: Response OK

77. Drawing 5-3

Label the sliver of waste rock (?) overlying the Dinwoody Formation and Qw between Stations approximately between 1300 and 2000.

Note that having an additional Dinwoody Formation monitoring well north/northwest of this section, under MWD085, would allow for extending this cross section to the north to illustrate a larger picture of groundwater elevations and apparent gradient in the Dinwoody Formation, and provide a more complete CSM. As noted previously, lack of a Dinwoody Formation monitoring well under MWD085 is considered a data gap that should be addressed; see General Comment B for direction.

P4 Response (SC-77)*: The sliver of waste rock pile MWD088 on Drawing 5-4, Section V-V', has been labeled. Drawing 5-3 is Section N-N', which does not cross MWD088. See responses SC-54 for discussion of the Dinwoody Formation and waste rock dump MWD085.*

A/T Comment: Response OK (A/T comment mistakenly referenced Drawing 5-3, but meant 5-4)

78. Drawing 5-4

Reference somewhere that Drawing 2-2 shows the location of Cross Section V-V'.

P4 Response (SC-78)*: Notes have been added to Drawings 5-2, 5-3, and 5-4 indicating that all the cross sections drawn for the Henry Site are indexed on the Drawing 2-2 (which also provides the site geology).*

A/T Comment: Response OK

Appendix A – Risk Assessment

79. Appendix A; Page 2-2

Suggest additional bullet to BRA representativeness list:

- Human representativeness: Are surface soils and sediments sized to represent particles likely to adhere to skin and consequently ingested? If not, discuss as an uncertainty.

https://semspub.epa.gov/work/HQ/100000133.pdf

P4 Response (SC-79)*: The referenced document is applicable to evaluation of lead-contaminated sites where lead shot may be present, and is not applicable to the P4 Sites based on site history and the nature of the contamination that is present. Therefore, we do not believe that a discussion of particle size is appropriate for the representativeness bullets on Page 2-2. However, the final bullet of Section 6.1 of Appendix A has been revised to include a discussion of soil particle size as related to oral exposures.*

A/T Comment: Although the document was prepared by the EPA Technical Workgroup for Lead, the supporting studies are based on particle size as a controlling variable for dermal adherence and subsequent percutaneous absorption and ingestion. The results are fully applicable to assessing human exposure to all particulate contaminants in soil (Ruby and Lowney 2012, Stalcup 2016).

80. Appendix A; Page 3-1

Update risk estimates using the most recent version of the EPA Superfund Exposure

Factors (2014): https://www.epa.gov/risk/update-standard-default-exposure-factors

P4 Response (SC-80)*: The primary source for exposure factors used in the Ballard Site BRA was IDEQ (2004), as described in the A/T-approved RI/FS Work Plan; these exposure factors have been retained in the Henry Site BRA for consistency between the P4 Sites. The updated USEPA exposure factors are not significantly different from the IDEQ exposure factors used in BRAs for the Ballard and Henry Sites.*

A/T Comment: Response OK

81. Section 3.1; Page 3-2; Paragraph 3; Last sentence

Add to Section 3.1 that EPA Regional Screening Levels (RSLs) (2015a) were also used in the screening process of constituents of potential concern (COPC) in surface and groundwater. Use the most updated citation of the RSLs (May 2016) if indeed values evaluated for the Henry Site are the same as EPA 2015 RSLs.

P4 Response (SC-81)*: Please note that USEPA RSLs currently are listed under surface water as source number 3, and under groundwater as source number 1 on Page 3-3. At the time of selection of COPCs, the most current version of the USEPA RSLs was November 2015. However, prior to submittal of the draft Henry RI Report in August 2016 the November 2015 RSLs were compared with the May 2016 RSLs to ensure that the semi-annual revision did not affect the COPC selection for the Henry Site. Text describing this comparison has been added to Section 3.1.*

A/T Comment: Response OK

82. Section 3.1, Page 3-2, Paragraph 3

The National Recommended WQC listed is out of date. The most recently published version is July 28, 2016. Update reference accordingly in the text and tables throughout the report.

P4 Response (SC-82)*: The reference to the USEPA's NRWQC website has been updated to 2016 as requested.*

A/T Comment: Response OK

83. Section 3.1, Page 3-2, Paragraph 3

The EPA's RSL is out of date. The most recently published version is May 2016. Update reference accordingly in the text and tables throughout the report.

P4 Response (SC-83)*: Please refer to the response to SC-81.*

A/T Comment: Response OK

84. Section 3.3, Page 3-4, last paragraph.

As recommended by EPA's ProUCL software, the upper confidence limit (UCL) (95 percent or other) should be used as the EPC and not default to a maximum detected concentration (MDC) that is lower than that UCL. EPA no longer recommends defaulting to the MDC. The MDC is not recommended for risk assessment purposes because for small (for example, n < 10 to 20) or skewed data sets it does not provide the specified 95 percent coverage to the population mean, and for larger data sets it typically overestimates the EPC. If the MDC is below the UCL, then the question should be asked whether the data set is sufficient for risk assessment purposes and whether a data gap exists. While this situation may be unavoidable for some media (for example, as a result of limited numbers of culturally significant vegetation available to sample), the uncertainties it imposes on the risk estimate need to be fully discussed in the uncertainty section of the report. Looking at the EPC summary tables (Tables A3-8 through A3-14), it appears that the maximum detected value was only selected for culturally significant vegetation (CSV), which is unavoidable due to the limited availability of these plant types. Therefore, revise the text to indicate that the recommended UCL from ProUCL was used for all media except for CSV, which limited samples required defaulting to the maximum detected concentrations.

> ***P4 Response (SC-84)***: *Text in Section 3.3 has been revised as follows: "The Tier II HHRA evaluated EPCs based on upper-bound average concentrations ~~of EPCs (i.e., the lower of either the maximum detected concentration or the ProUCL recommended 95%, 97.5%, or 99% upper confidence limit [95% UCL; 97.5% UCL; 99% UCL]) on the mean concentration~~, using both RME and CTE exposure assumptions. Tier II EPCs were equal to the ProUCL recommended 95%, 97.5%, or 99% upper confidence limit (95% UCL, 97.5% UCL, or 99% UCL) on the mean concentration for all analytes and media where there were sufficient number of detected sample results to perform statistical evaluations. For analytes and media with insufficient detected sample results (e.g., several analytes in upland culturally significant vegetation tissue), the EPC was equal to the maximum detected concentration."*
>
> **A/T Comment:** Response OK

85. Section 3.3.1.2; Page 3-6; Paragraph 3

The document states: "A review of the USEPA's Exposure Factors Handbook (USEPA, 2011) indicates that only about 1% of inhabitants in the Western U.S. consume wild game, and less than 1% (i.e., 0.6%) of Native Americans consumes wild game. Furthermore, mean intake rates of wild game by Western U.S. residents and Native Americans are 0.012 grams per kilogram per day (g/kg-d) and 0.001 g/kg-d, respectively. In comparison, mean intake rates for 'total meats' by Western U.S. residents and Native Americans are 1.903 g/kg-d and 2.269 g/kg-d, respectively. As a result, wild game contributes only about 0.63% of the total meat consumed by Western U.S. residents and 0.044% of the meat consumed by Native Americans." The reviewer was not able to locate this information in the 2011 EPA Exposure Factors Handbook; please specify the table, chapter, or the study cited in this document that contains these assertions.

> ***P4 Response (SC-85)***: *The percent consuming and per capita consumption rates are presented in Table 11-6 of the 1997 version of the Exposure Factors Handbook (EFH). The 1997 EFH included statistics for consumption of game in Chapter 11, which addresses overall meat consumption, while the 2011 EFH includes statistics for consumption of game in Chapter 13, which only addresses home-produced food. Table 13-41 of the 2011 EFH indicates that approximately 1% of people in the west*

consume game, consistent with Table 11-6 of the 1997 EFH. Table 13-41 does not have a percent consuming for Native Americans. Because the 2011 EFH does not have statistics for Native Americans, 1997 EFH Table 11-6 statistics for percent consuming wild game were retained in text. The text in Section 3.3.1.2 has been modified to remove the per capita meat ingestion rates.

A/T Comment: Response OK

86. Section 3.3.1.2; Page 3-6

If the mean is the average of 1 percent of consumers and the 99 percent who don't consume, then this a misleading statement. Because the purpose of the risk assessment is to assess the risk to exposed people, it is inconsistent to estimate exposure factors by averaging rates of exposed and unexposed people. The risk to people consuming wild game must be based on *their consumption rate,* not the average of consumers and nonconsumers. Based on this text, it appears that game consumption rates were significantly underestimated. The consumption rate should be based on an upper percentile estimate of consumers; not a per capita estimate. The 2011 EPA Exposure Factors Handbook should be referenced to correct this value.

P4 Response (SC-86)*: The purpose of text in Section 3.3.1.2 is to indicate that game consumption rates in the western United States and among Native American populations are low, and therefore there is minor uncertainty associated with evaluating only one game species (i.e., elk). Text comparing per capital game ingestion rates to per capita meat ingestion rates has been removed from Section 3.3.2.1 the revised BRA. Please refer to P4's response to SC-87 for a discussion of the game ingestion rates that are used in the Henry Mine BRA.*

A/T Comment: Response OK

87. Section 3.3.1.2, P3-6, Paragraph 3

The wild game consumption rates provided in this section seem to be quite low for those populations that do consume wild game; these rates could not be located in the referenced document by this reviewer to verify. Provide additional information on where these rates were taken.

P4 Response (SC-87)*: Consumption rates for wild game are consistent with rates used in the approved Ballard Site BRA, and were derived as described in footnote s to Table A3-7:*

> *The ingestion of game rates for a seasonal hunter were time-weighted ingestion rate for ages 16-46 from Table 13-41 of USEPA's Exposure Factors handbook (2011b) and adjusted for 29.7% meat preparation and cooking loss and 29.7% post-cooking loss (Table 13-69 from USEPA 2011b), consistent with the human health risk assessment technical memorandum for the Smoky Canyon Mine Site (Formation Environmental LLC, 2013). The CTE (mean) and RME (99th percentile) adult Native American ingestion of game rates were obtained from Table 11-6 of the 1997 Exposure Factors Handbook (USEPA, 1997b). The child Native American ingestion rates were estimated from the adult ingestion rates assuming a child eats 45% of the meat consumed by an adult (based on values in Table 13-1 of USEPA, 2011b). All grams per kilogram per day adult ingestion rates were converted to grams per kilogram assuming a body weight of 70 kilograms.*

A/T Comment: Meat cooking losses consist of water or fats, this may not be appropriate for selenium, cadmium, and other COPCs which are likely bound to sulfhydryl sites on proteins. Please address.

88. Appendix A; Page 3-8

Consider globally replacing "receptors" with "exposed" or "potentially exposed people."

> ***P4 Response (SC-88)****: Comment Noted. "Receptors" is common risk assessment terminology for the potentially exposed populations being evaluated, as defined in Section 3.3.1.2. Because "receptors" is a simple term with one meaning within the risk assessment, it can be used in a variety of sentence formats without the ambiguity that might occur with a longer phrase such as "potentially exposed people."*
>
> **A/T Comment:** Response OK

89. Section 3.3.2.1, Page 3-11, last paragraph, last sentence

See previous comment regarding the MDC. EPA's ProUCL software, the UCL (95 percent or other) should be used as the EPC and not default to an MDC that is lower than the UCL. EPA no longer recommends defaulting to the MDC.

> ***P4 Response (SC-89)****: Please refer to the response to SC-84.*
>
> **A/T Comment:** Response OK

90. Appendix A; Page 3-12

Use the most recent version of ProUCL Software (v. 5.1) available at:

https://www.epa.gov/land-research/proucl-software

> ***P4 Response (SC-90)****: The 95% UCL on the mean concentrations for Henry Site datasets were calculated prior to the release of ProUCL v 5.1. However, comparison of a subset of Site EPCs calculated using ProUCL v. 5.1 to EPCs calculated using ProUCL v. 5.0 indicates that risk estimates recalculated based on EPCs derived using ProUCL v. 5.1 differ only slightly (if at all) from current risk estimates. Based on the above, P4 believes that the level of effort required to recalculate EPCs for all COPCs and COPECs in all media based on ProUCL v. 5.1 is not warranted.*
>
> **A/T Comment:** Response OK

91. Section 3.3.2.2; Page 3-12

Suggest moving all this section as a new attachment (Exposure Estimation Equations for HHRA).

> ***P4 Response (SC-91)****: Comment noted. Although this section is lengthy, it contains information that reinforces methods described elsewhere in the report, and is most appropriate as a subsection to Section 3.3.2.*
>
> **A/T Comment:** Response OK

92. Appendix A; Page 3-24

Replace the outdated IRIS Uranium RfD with the ATSDR oral MRL value (see attached correspondence expressing support from EPA Head Quarters): http://www.atsdr.cdc.gov/toxprofiles/tp150.pdf

***P4 Response (SC-92)**: Please refer to the response to GC-C.*

A/T Comment: Please update to incorporate revised EPA Guidance recommending use of the ATSDR MRL in place of the MCL or IRIS RfDs

https://semspub.epa.gov/work/HQ/196808.pdf

93. Appendix A; Page 3-27

The EPA preliminary remediation goal calculator can accept user-derived exposure or toxicity values included in the Particle Emission Factor.

***P4 Response (SC-93)**: The particulate emission factor (PEF) used in inhalation dose calculations for chemicals in the BRA for the Henry Site was calculated using the PEF equation in Appendix D of the USEPA's Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (USEPA, 2002) and default parameter values in Idaho Department of Environmental Quality's (IDEQ's) Idaho Risk Evaluation Manual (IDEQ, 2004), including a default value for the variable Q/C_{wind}. The EPA calculator, which was used to calculate preliminary remediation goals (PRGs) for radium-226 in the BRA for the Henry Site, does accept user-derived values for the site area (A_s), mean annual windspeed (U_m), equivalent threshold value (U_t) fraction vegetated cover (V), and (by default, given U_m and U_t), f(x). However, The value of Q/C_{wind}, is calculated in the calculator based on the user-input A_s and user-input climatic zone. The value of Q/C_{wind} generated by the calculator for Boise, Idaho is significantly different than the value of Q/C_{wind} in IDEQ (2004), which is approximately equal to the Q/C_{wind} value for a 0.5 acre site in Boise, Idaho from USEPA (2002). It should be noted that the values of the constants A, B, and C used to calculate the Q/C_{wind} in the EPA's online preliminary remediation goal calculator are significantly different than the values of these constants in Appendix D of USEPA (2002).*

The PEF value in the EPA's calculator could have been matched to the PEF value calculated from IDEQ (2004) by inputting a made-up value, rather than the standard default, for a user-provided input parameter. However, the contribution inhalation of contaminated dust makes to the total radiological dose is much less than the contribution from incidental ingestion of soil, and completely insignificant compared with the contribution due to external exposure to radiation associated with contaminated soil. Because the PEF will not affect the outcome of the BRA for radium-226, the calculator was not artificially manipulated to achieve a desired PEF.

A/T Comment: Response OK

94. Section 4.1.1.2; Page 4-2; Paragraph 2; After Line 11

It appears that not the same constituents were selected as constituents of potential ecological concern (COPEC) in upstream, downstream, and pond surface water. For example, cobalt, copper and thallium were selected in downstream and pond surface water, but not in upstream water (Table A4-3). Antimony was selected in upstream and pond surface water, but not in downstream surface water (Table A4-4). Please include an explanation in Section 4.1.1.2 for not selecting the same list of constituents in all surface water samples tested at the site (Tables A4-3 through A4-5).

Incorporate some text in this section regarding the final 2016 Aquatic Life Ambient Water Quality Criterion for Selenium in Freshwater and the fact that new values are available for lotic and lentic surface waters but that P4 used the draft value of 0.005 mg/L.

P4 Response (SC-94)*: Separate screening tables were created because hardness, and therefore hardness-dependent criteria for some metals, varies between upstream, downstream, and pond surface water sampling locations. The list of analytes is not identical between Tables A4-3 through A4-5 because Screening tables for all media include only detected analytes. The final surface water COPECs listed in Table A4-7 includes all COPECs identified in Tables A4-3 through A4-5. Text in the first paragraph of Section 4.1.1.2 has been revised to clarify this point.*

Regarding the use of the final 2016 Aquatic Life Ambient Water Quality Criterion for Selenium, please note that the text does cite the new selenium criterion for lotic systems However, the criterion was released after the screening had been performed, and because selenium was already a COPEC based on existing criteria, Tables A4-3 through A4-5 were not updated in the draft report. In the revised report, the screening value for lentic systems has been added to the final paragraph of Section 4.1.1.2, and the new criteria for lotic and lentic systems have been added to Tables A4-3 and A4-4 (lotic criterion) and A4-5 (lentic criterion).

A/T Comment: Response OK

95. Section 4.2, Page 4-3, last paragraph, Sentence 1

Suggest removing the word "process" from this sentence so it reads more clearly.

P4 Response (SC-95)*: The word "process" has been replaced by "ERA."*

A/T Comment: Response OK

96. Section 4.2.1.1, Page 4-4, Paragraph 2, Sentence 1

Suggest revising "Disregarding the influence of environmental contaminants …" to read as "Disregarding the influence of environmental contaminants and physical disturbance …"

P4 Response (SC-96)*: Agreed; text has been modified as requested.*

A/T Comment: Response OK

97. Section 4.3.1; Page 4-21; Paragraph "Amphibian and Fish/American Goldfinch"

Although the methodology used to assess the risk of amphibians is appropriate, in the case of fish it would be more appropriate to use fish tissue data when available. It appears that some tissue data has been collected (Table 4-18); if the species of these forage fish (redside shiners, speckled dace) tissue concentrations are available then it would be valuable to incorporate these data in the ERA. Otherwise, an acknowledgement of the lack of this information and how this affects the overall risk assessment should be mentioned in the uncertainty section.

The HQ for the American goldfinch for silver is 0.12, so delete silver from the list of COPCs exceeding an HQ of 1.

P4 Response (SC-97)*: Fish tissue data have been added in a table embedded in text and evaluated qualitatively.*

Silver has been deleted from the list of COPECs exceeding an HQ of 1 for the American goldfinch.

A/T Comment: Response OK

98. Section 4.3.2; Page 4-24; Paragraph 3; Lines 2-5

Modify the text to read similar to: "Excess hazard associated with antimony in the Henry Mine upland soil was also calculated for deer mouse and mink; however, similar to the long-tailed vole, hazards associated with antimony in upland soil for these two constituents was greater at background location than at site."

P4 Response (SC-98)*: Please clarify if the intent of this revision is to add the mink to this paragraph. This change has not made, as the mink is a riparian receptor and is not exposed to upland soil. However, as noted in the response to SC-61, which requested that the presentation of risk results in Section 6.6.2 of the RI be receptor-specific, comparisons between hazards for Site and background media and conclusions regarding risk drivers have been moved to a new Section 4.3.3 of Appendix A. Similarly, text comparing hazards for Site and background media have been moved from receptor-specific results in Section 6.6.2 of the RI to Section 6.9.4 of the RI.*

A/T Comment: Yes, the intent of the comment was to include the mink to this paragraph. Agreed the mink is a riparian receptor. Thus, no changes needed.

99. Section 4.3.2; Page 4-25; Paragraph 2; Lines 2-5

Modify the text to read similar to: "Excess hazard associated with antimony in the Henry Mine upland soil was also calculated for long-tailed vole and mink; however, similar to deer mouse, hazards associated with antimony in upland soil for these two constituents was greater at background location than at site."

P4 Response (SC-99)*: Please refer to the response to SC-98.*

A/T Comment: Please refer to A/T comment to response for SC-98.

100. Section 4.3.2; Page 4-25; Last Paragraph

Change the range to 0.013 to 3.8 or revise the LOAEL-based value for thallium in Table A4-25.

P4 Response (SC-100)*: The hazard for thallium was inadvertently reported as 0.031 in text, and has been revised to 0.013.*

A/T Comment: Response OK

101. Section 5.1; Page 5-1; Paragraph 4; Last Sentence

The document cites Table 7-4 of the Conda/Woodall Mountain Mine RI/FS Site-Specific Livestock Risk Assessment Problem Formulation (Formation Environmental, 2013). This citation is accurate; however, it would be more appropriate to cite the 2016 Final Livestock Risk Assessment Report Conda/Woodall Mountain Mine. Table 4-4 of this document has toxicity reference values for Evaluation of Drinking Water Ingestion by Livestock – Other Chemicals of Interest. Please cite this final document.

P4 Response (SC-101)*: Agreed. The updated reference has been cited in the revised report.*

A/T Comment: Response OK

102. Section 5.2.1.1; Page 5-3; Paragraph "Livestock grazing"

It would be helpful to provide additional details in this section (for example, grazing allotment areas [if any], acreage of each allotment area, any restrictions in any of these grazing areas resulting from elevated selenium concentrations, and a map with the location of these grazing areas within the Henry Mine Site).

> ***P4 Response (SC-102)****: The LRA is a conservative hypothetical evaluation that utilizes Site-wide EPCs to evaluate potential risks to future livestock grazing anywhere on-Site; risks to livestock were not evaluated based on current or potential future grazing allotments. Therefore, this information is not applicable to Appendix A of the RI. However, the requested information will be described in Section 2.0 of the revised RI Report and the future Henry Site Feasibility Study (FS), as it relates to evaluation of remedial measures including best management practices (BMPs) and/or institutional controls (ICs).*
>
> **A/T Comment:** Response OK

103. Section 5.2.1.2; Page 5-4; Paragraph "Terrestrial environment;" Last Line

This citation is partially accurate. "…adverse toxicity effects from toxicity adverse effects from toxicity may be reversed if the adverse effects did not include developmental deformities" could not be found in USDOI, 1998. Cite appropriate document or delete this portion of the text.

> ***P4 Response (SC-103)****: The second paragraph on page 143 of the referenced document (USDOI, 1998) states: "Selenium accumulates in and disperses from animal tissues fairly rapidly. Significant changes in tissue selenium status can occur within days, weeks, or months depending on the response criterion of interest and the target tissue being monitored (Wilber 1980; Bennett et al. 1986; USFWS 1990a; Heinz et al. 1990; Heinz and Fitzgerald 1993a; Heinz 1993). Furthermore, the overt symptoms of even near-fatal selenium poisoning in adult birds and mammals can be reversed quickly if the source of selenium exposure is eliminated (Ruta and Haider 1989; Heinz and Fitzgerald 1993b). By contrast, embryonic deformities caused by selenium poisoning are not reversible (Lemly 1993b), nor are some types of tissue damage in adult animals (Sorensen 1991)." No changes to the text were necessary.*
>
> **A/T Response:** Based on the cited document (USDOI, 1998) rephrase the text similar to: "adverse toxicity effects in adult birds and mammals can be reversed if the source of selenium exposure is eliminated. On the contrary embryonic deformities due to selenium poisoning are not reversible." As it is written, the text suggests that adverse effects from toxicity from selenium maybe reversed only if the effects did not include developmental deformities; however, the key point is that selenium toxicity can be reversed if only exposure to selenium is eliminated.

104. Table A3-1

- Change the nomenclature of the analyte Radium-226 to Radium-226+D in the analyte column and in note "d". The PRG value for Ra-226+D (radium+ daughter products) using the EPA's PRG calculator as a default for soil is 0.0063 picoCuries per gram (pCi/g); however the value for Ra-226 is 1.15E-02 pCi/g.

- The notes indicate: "All the concentrations in mg/kg except for radium-226, which is in picoCuries per kilogram (pCi/g)." There is an inconsistency in the units in the text and what is shown in parenthesis. Please change the text to picoCuries per gram.
- Note "b" has a typo.

P4 Response (SC-104): *The analyte column lists constituents as they are identified in the analytical results, rather than as the form for which screening values are available/selected. Footnote d has been corrected to indicate that radium-226 was screened against the PRG for Radium-226+D, rather than radium-226. Additionally, the "*picoCuries per kilogram" *typo in the first note has been corrected to read "*picoCuries per gram" *and the "ths" typo in footnote b has been corrected to read "this."*

A/T Comment: Response OK

105. Table A3-3

Note 3 needs to indicate that the RSL Resident Tapwater for carcinogens corresponds to a cancer risk of one in 1 million (TR=1E-06), and for noncarcinogens the HQ is equivalent to 1. Please provide the rationale for using an HQ of 1 for surface water instead of the HQ of 0.1 used in upland soil and sediments (Tables A3-1 and Table A3-4). This information should also be included in Section 3.1.1 (Surface Water) of Appendix A.

P4 Response (SC-105): *Note 3 has been revised to indicate that the RSL Resident Tapwater for carcinogens corresponds to a cancer risk of one in 1 million (TR=1E-06), and for noncarcinogens the HQ is equivalent to 1. The use of RSLs based on an HQ of 1 is consistent with the RI/FS Work Plan and with the Ballard Site BRA. The use of RSLs based on a target HQ of 1 is also consistent with the HQ basis of other surface water screening criteria in Table A3-3, including State of Idaho Surface Water Quality for Domestic Water Supply Use (IAC, 2009) and National Recommended Water Quality Criteria (USEPA, 2015).*

A/T Comment: Response OK

106. Table A3-3

This surface water screening inappropriately uses dissolved concentrations. The standards for protection of human health (DEQ's domestic use, and EPA's MCLs and PRGs) are based on total metals concentrations. The surface water screening tables should be revised to include total concentrations similar to that presented for groundwater.

P4 Response (SC-106): *Please note that the surface water sampling program for the P4 Sites measures dissolved concentrations for all COPCs, except selenium, as described in the 2009/2010 Surface Water Sampling and Analysis Plan (MWH, 2009). In addition, background levels were developed for dissolved concentrations of all COPCs in surface water, with the exception of selenium, as described in the 2013 Background Levels Tech Memo (MWH, 2013). As a result, the available surface water data for all metals and metalloids are expressed as dissolved concentrations.*

A/T Comment: Comments 106, 108, and 114 all describe the same issue where dissolved metals concentrations were compared with DEQ's domestic use, EPA's MCLs, and EPA's PRGs that are based on total metals concentrations. The response indicates that total metals data are unavailable with the exception of selenium. This likely results in an underestimation of risk to humans and certainly for wildlife potentially ingesting surface water at the site since they would not be filtering the water they drink. There does not appear to be any discussion on this non-conservative assumption within the risk characterization and uncertainties discussion. Text needs to be added describing how the exposure to these receptors may be understated.

107. Table A3-5

Footnote "f" (indicating that these constituents were eliminated from further consideration as a result of their low toxicity and being essential nutrients) is unnecessary since none of measured concentrations exceed screening levels, which is a better indicator of the protectiveness.

P4 Response (SC-107): *The only essential nutrient with an available screening criterion is iron. Although iron does not exceed this screening level, footnote "f" has been retained for all essential nutrients because low concentrations and essential nutrient status are equal indicators of protectiveness. According to the COPC selection methodology used in the Henry BRA, constituents without screening levels are retained for quantitative risk evaluation. In this case, were it not for the "essential nutrient status" calcium, magnesium, potassium, and sodium would have been retained as COPCs.*

A/T Comment: Response OK

108. Table A3-6

Again, footnote "a," which indicates surface water COPCs are all in the dissolved form except for selenium, is not correct. Total concentrations should be used for screening versus human health standards.

P4 Response (SC-108): *Please refer to the response to SC-106, above.*

A/T Comment: Please refer to A/T comment to response for SC-106.

109. Table A3-13

The two occurrences of "surface water stations" should be changed to "sediment stations" since this is the sediment summary statistics table.

P4 Response (SC-109): *Table A3-13 has been modified as indicated.*

A/T Comment: Response OK

110. Table A3-30

Note "a" indicates that risk estimates for all COPCs are presented in Attachment C. Attachment C presents Tier I background and Human Health Risk Calculations, not Tier II calculations. Please change this reference to Attachment D.

P4 Response (SC-110): *The reference has been changed to Attachment D.*

A/T Comment: Response OK

111. Table A4-1

The column Lowest Soil Screening Level appears to have some inconsistencies. For example, the constituents arsenic, manganese, nickel, and silver are not the lowest concentrations from all of the screening values provided. Make appropriate changes or provide rationale for the selection of the lowest soil screening level in the table's notes and in Section 4.1.1.1 of Appendix A.

P4 Response (SC-111): *The noted inconsistencies have been corrected in the revised BRA. Please note that this correction did not affect the ecological screening results.*

A/T Comment: Response OK

112. Table A4-2

The column "Lowest Soil Screening Level" appears to have some inconsistencies. For example, nickel and silver are not the lowest concentrations from all the screening values provided. Make appropriate changes or provide rationale for the selection of the lowest soil screening level in the table's notes and in Section 4.1.1.1 of Appendix A.

P4 Response (SC-112): *The noted inconsistencies have been corrected in the revised BRA. Please note that this correction did not affect the ecological screening results.*

A/T Comment: Response OK

113. Table A4-3

Revise the hardness value used for the State of Idaho Standards Aquatic Life to 400 mg/L in note "a" to be consistent with statements in Section 4.1.1.2. Provide the reason(s) why cobalt was not included in the list of analytes in Table A4-3. This is inconsistent with the information presented in Table A4-7 (that is, cobalt is a constituent of potential concern in surface water).

P4 Response (SC-113): *The hardness typo in footnote "a" has been corrected as noted. Cobalt is not included in COPEC screening for upstream surface water in Table A4-3 because it was not detected (refer to table A2-5). However, cobalt is listed as a COPEC for the Henry Site in Table A4-7 because it was selected as a COPEC in downstream surface water.*

A/T Comment: Response OK

114. Table A4-3

The EPA water quality criteria for aluminum, iron, and selenium are based on total concentrations. This table and any others using dissolved concentrations for aluminum and iron should be revised to include total concentrations for comparisons to these criteria.

P4 Response (SC-114): *Please refer to response to SC-106.*

A/T Comment: Please refer to A/T comment to response for SC-106.

115. Table A4-4

Revise the hardness value used for the State of Idaho Standards Aquatic Life to 256 mg/L in note "a" to be consistent with statements in Section 4.1.1.2.

P4 Response (SC-115): *The hardness typo in footnote "a" has been corrected as noted.*

A/T Comment: Response OK

116. Table A4-15

Section 4.2.1.1 indicates that plant tissue concentrations were based on measured concentrations, when available, instead of modeled concentrations. Add a footnote to this table that describes the modeled approach as being used only when sufficient data were unavailable for using measured tissue concentrations.

P4 Response (SC-116): *The approach for calculating plant tissue doses is clearly described in text and in applicable tables (e.g., Table A4-22, Table F-1, etc). However, a note indicating that modeled plant tissue concentrations were calculated only when measured plant tissue data were insufficient has been added to the BAF table (A4-15).*

A/T Comment: Response OK

117. Table A4-21

Please provide the rationale for evaluating surface water data as one exposure unit. Although aggregating data for surface water and sediment over the entire site to calculate a 95% UCL of the mean may be appropriate for exposure to upper trophic level wildlife, it is not appropriate for exposure to fish and amphibian populations that are likely to be exposed within individual streams or ponds. The risk to aquatic resources (where present) using ponds and streams need to be evaluated independently.

P4 Response (SC-117): *Please refer to the response to SC-69.*

A/T Comment: Response OK

118. Table 6-15 and Table A4-7

Note "b" - It would also be good to point out that the maximum manganese detected in soils at the Henry Mine Site (2,580 milligrams per kilogram [mg/kg]) is below the background level identified in MHW (2015) document (3,460 mg/kg) here and the text of the document.

P4 Response (SC-118): *Because the BRA includes calculation of hazard based on background concentrations, background is not used in the screening process. No revisions to the report are necessary.*

A/T Comment: Response OK

119. Table B-27

The chemical-specific HQ for selenium (1.2E-01/5.0E-03) is 24, not 23. Please make appropriate changes in this table and throughout the document.

***P4 Response (SC-119):** Please note that although numbers shown in tables are rounded, the full value was carried through the calculation, from EPC to hazard estimate. The dose in Table B-27 is actually 0.115 mg/kg-d, corresponding to a HQ of 23. No revisions to the report are necessary.*

A/T Comment: Add text to the paragraph after Equation 27 in section 3.3.4, page 3-26 to clarify that although values for modeled or measured ingestion doses shown in tables in Attachments B and J are rounded to two significant figures (i.e., one decimal place) HQ calculations were made using modeled or measured ingestion doses rounded to four significant figures (i.e., three decimal places).

120. Table B-30

The chemical-specific HQ for thallium (1.3E-03/1.0E-05) is 130, not 128. Please make appropriate changes in this table and throughout the document.

***P4 Response (SC-120):** Please note that although numbers in tables are rounded, the full value is carried through the calculation, from EPC to hazard estimate. The dose in Table B-30 is actually 0.00128 mg/kg-d, corresponding to a HQ of 128. No revisions to the report are necessary.*

A/T Comment: Please refer to A/T comment to response for SC-119.

121. Table B-42

The chemical-specific HQ for selenium (2.3E-01/5.0E-03) is 46, not 45. Please make appropriate changes in this table and throughout the document.

***P4 Response (SC-121):** Please note that although numbers shown in tables are rounded, the full value was carried through calculation, from EPC to hazard estimate. The dose in Table B-42 is 0.225 mg/kg-d, corresponding to a HQ of 45. No revisions to the report are necessary.*

A/T Comment: Please refer to A/T comment to response for SC-119.

122. Table J-1

The ecological hazard for selenium (1.2/1.4E-01) is 8.6, not 8.2. Please make appropriate changes in this table and throughout the document.

***P4 Response (SC-122):** Please note that although numbers shown in tables are rounded, the full value was carried through calculation, from EPC to hazard estimate. The dose in Table J-1 is 1.17 mg/kg-d, and the TRV is 0.143 mg/kg-d, corresponding to a HQ of 8.2. No revisions to the report are necessary.*

A/T Comment: Please refer to A/T comment to response for SC-119.

Appendix C – Photographic Log

123. Appendix C; Page 1 of 6; Photo Location MST052

The sign in the photo indicates that this is site MST051. Reconcile.

P4 Response (SC-123): *This photo has been removed from the revised report as the photo for MST051 is located on Page 11 of the appendix.*

A/T Comment: Response OK

Editorial Comments Table

Henry Mine

Editorial Comments

Item No.	Section; Table; Figure	Page	Paragraph	Line (if not obvious)	Agency/Tribe Comments	Did P4 Respond to Comment
	ES.4	ES-3	4 “Riparian Soil”	2	Delete second “investigations” as it is redundant.	
	ES.4	ES-3	3	Sentence 1	Insert “the” to read “… summary of the principal findings for the RI program …”	
	ES.4.1	ES-4	2	10	Delete “reclaimed” as it is redundant.	
	List of Drawings	ix	Drawing 5-2		There is no reference to this drawing in the text. Revise accordingly.	
	Acronyms and Abbreviations	xi			“ILCRs” is not in alphabetical order. Correct.	
	1.0	1-1	1	8	Insert “and” to read “… and the Shoshone-Bannock Tribes (Tribes).”	
	1.2.2.	1-4	Footnote	2	Delete “numeric” as it is redundant.	
	1.2.3	1-6	1 (partial)	4	Change to “Engineering Evaluation /Cost Analysis (EE/CA).”	
	1.2.3	1-6	2 (last)	1	Insert “into” to read “… entered into a new …”	
	2.3.2	2-5	5 (last)	1	Insert a comma to read “(i.e., MDS016).”	
	2.4	2-7	3 (last)	2	Insert a period to read “Oberlindacher, et al. (1982)” for consistency.	
	2.5.2	2-10	1 “Grasses”	1	Insert a space to read “*Bromus inermis*.”	
	2.6.2	2-13	3 (last)	3	Insert “road” to read “… P4 Enoch Valley haul road traverses …”	
	2.6.2.2	2-14	3 (last)	3	Insert “how” to read “… and ultimately how wells and …”	
	2.6.2.2	2-16	1	4	Insert “is” to read “… which is at a depth …”	
	2.6.2.2	2-16	1	Sentence 4	Change to read “The temperature data appear to respond to seasonal fluctuations …”	
	2.6.2.2	2-16	2 (last)	3	Insert a comma to read “… Enoch Valley Mine, is …”	

Henry Mine

Editorial Comments

Item No.	Section; Table; Figure	Page	Paragraph	Line (if not obvious)	Agency/Tribe Comments	Did P4 Respond to Comment
	2.6.2.2	2-20	1 (partial)	4	Replace "and as" with "which" to read "… producing a "noisy" hydrograph, which is typical …"	
	2-7	2-21	1	3	Insert "in" to read "… discussed in the *Area-Wide Assessment* …"	
	2.10.1	2-24	3	2	Change to "Table 2-7."	
	2.10.2	2-27	2	3	Change "freshwater criteria" to "surface water criterion."	
	3.5	3-7	4	7	Change "Section 3.6.3" to "Section 4.6.3."	
	4.3	4-15	2	6	Change "was" to "were" for subject-verb agreement to be consistent with the rest of the document where data is treated as plural. Check all instances to make sure this is consistent throughout the report.	
	4.4.1	4-23	3	2	Change "are exceeded" to "exceed" to read "… and often only exceed in one …" for easier reading.	
	4.4.1	4-24	1 (partial)	Sentence 2	Change to "exceeds" and "criterion" to read "… and there is only one sporadic or anomalous result that slightly exceeds the hexavalent chromium screening criterion, chromium is not discussed further.	
	4.4.2	4-26	2	5	Insert "spring" to read "… with spring exceedances of the selenium …"	
	4.4.4.1	4-29	2	6	Change to "criterion" to read the "… the screening criterion for cadmium …" Check the entire document for instances where the singular criterion should be used in lieu of the plural criteria.	
	4.4.4.1	4-30	1	3-4	Change to "criterion" for both occurrences.	
	4.4.4.1	4-31	2	Sentence 2	Delete "at" to read "Dissolved arsenic concentrations range from …"	
	4.4.4.2	4-31	3	Sentence 3	Change to "stations" to read "… for these stations are reported …"	
	4.5	4-34	5 (last)	3	Change "is" to "are" to read "Groundwater samples collected and analyzed from these wells are used …" for subject-verb agreement.	

Henry Mine

Editorial Comments

Item No.	Section; Table; Figure	Page	Paragraph	Line (if not obvious)	Agency/Tribe Comments	Did P4 Respond to Comment
	4.5.2.1	4-41	4 (last)	3	Delete "a" to read "… (SMCLs are used as reference points …"	
	4.5.3	4-51	2	Sentence 2	Add a hyphen to read "… piper diagram – Figure 4-23 – to evaluate …"	
	4.6.1.2	4-56	4	3	Delete the comma after "soil" to read "… or potential species use, soil and vegetation selenium …"	
	5.1.1.1	5-3	2	6	Change "were" to "where" to read "Therefore, the areas where mass wasting …"	
	5.1.2.2	5-4	5 (last)	2	Should it be "Detail A1" as opposed to "Detail A?" Revise accordingly.	
	5.1.2.2	5-5	1 (partial)	2	Change to "Details B2 and B3)."	
	5.1.4	5-7	2	3	Change "affects" to "affect" for subject-verb agreement.	
	5.1.4	5-7	4 (last)	1	Change to "Sections 2.1 and 2.4."	
	5.1.4	5-7	4 (last)	6	Insert "and" to read "…bedding and is either …"	
	5.1.4.3	5-10	2	11	Insert "the" to read "… flow towards the northwest …"	
	5.2	5-13	3	1	Switch the period and quotation mark to read "analyte specific."	
	5.3.3	5-18	3 (last)	2	Change to "Little Blackfoot River."	
	5.3.3	5-16	4	1	Change "affect" to "effect."	
	5.3.3	5-20	3	3	Change to "concentrations."	
	5.3.4	5-20	3	6	Delete "a" to read "…events at MMW010)."	
	5.3.4	5-20	3	8	Add "they" and change to "exceed" to read "… and they rarely exceed background levels."	
	5.3.4.1	5-21	1	4	Insert "a" to read "… is a more significant pathway."	
	5.3.4.1	5-21	3	Sentence 4	Change to "…directed northerly toward the river and then to a more westerly direction …" as it seems to read more smoothly.	

Henry Mine

Editorial Comments

Item No.	Section; Table; Figure	Page	Paragraph	Line (if not obvious)	Agency/Tribe Comments	Did P4 Respond to Comment
	5.3.4.1	5-23	3 (last)	13	Change "verses" to "versus."	
	5.3.4.3	5-26	2	Sentence 1	Change "… flow path that experiences reducing conditions …"	
	7.2.5	7-7	2	9	Change to "COC" to read "… as a preliminary COC for direct …"	
	7.2.6	7-8	5 (last)	1	Change "not affects" to "no effects."	
	7.2.8	7-11	2	5	Insert a semicolon to read "… noncancer criterion"	
	7.2.9	7-13	3	11 (last)	This reader is not sure what is meant be "detected Site." Revise.	
	7.3	7-14	4	1	Change to "These ecological risk estimates …"	
	Note 4	2-1			Change "of" to "for" to read "… accounts for the topography."	
	Note Orange shaded	4-9		2	Change "levels" to "level" to read "Selenium action level is …" for subject-verb agreement.	
	Drawing 2-3				Reference somewhere that Drawing 2-2 shows the location of Cross Section B-B'.	
	Drawing 5-2				Reference somewhere that Drawing 2-2 shows the location of Cross Section P-P'.	
	Drawing 5-3				Reference somewhere that Drawing 2-2 shows the location of Cross Section N-N'.	

P4 Response (editorial comments): *These comments have been addressed in the revised report.* **A/T Comment:** Response OK

References

Ruby, M. V. and Y. W. Lowney (2012). "Selective soil particle adherence to hands: implications for understanding oral exposure to soil contaminants." Environ Sci Technol **46**(23): 12759-12771. http://www.ncbi.nlm.nih.gov/pubmed/23148503
Stalcup, D. (2016). Recommendations for Sieving Soil and Dust Samples at Lead Sites for
Assessment of Incidental Ingestion. Washington, DC, Office of Land and Emergency Management**:** p. 34.
https://semspub.epa.gov/work/HQ/100000133.pdf

APPENDIX D-4

P4's Responses to Supplemental A/T Comments (dated April 13, 2017) on *P4's Henry Mine Remedial Investigation Report, Draft Rev 0, August 2016*

(Second set of P4 responses. Responses to A/T supplemental comments.)

Submitted to A/T on May 19, 2017

From: Drain, Vance <vance.drain@stantec.com>
Sent: Friday, May 19, 2017 1:36 PM
To: Tomten, Dave
Cc: MOLLY PRICKETT - P4 Monsanto (molly.prickett@monsanto.com); Leah Wolf-Martin (leah@wolfmartininc.com); Narloch, Bruce
Subject: P4's Responses to Supplemental A/T Comments on the initial RTC package - Henry RI/BRA Report
Attachments: P4sSuplemntlRTCs on Initl responsestoAT Cmnts_Henry Mine RI (05-19-17).docx

(b) (6)

Fellow Hydrogeologist/Senior PM
MWH, now part of Stantec
2890 E Cottonwood Pkwy, Suite 300
Salt Lake City, UT 84121 - USA
Phone: +1 (801) 617-3250
Cell: +(b) (6)
vance.drain@stantec.com

MWH is now part of the Stantec Family.

A/T Comments, P4's Responses, and A/T Follow-up Comments

Henry Mine Remedial Investigation (RI) Report

(Revision 0, August 2016)

General Comments

(Note: Final verification of responses will occur when Draft Final is submitted.)

A. Several portions of this report refer the reader back to the Blackfoot Bridge Environmental Impact Statement (EIS). Although referencing the report is valid, this report should be a stand-alone document, not one that relies on an EIS from another mine site. Please revise the Remedial Investigation (RI) report and for those discussions that refer to the EIS, add the appropriate discussions so that it is unnecessary for the reader to read the EIS or the Ballard RI report.

P4 Response (GC-A)*: This Henry RI Report, much as any other scientific publication relies on previous findings to confirm or further its scientific assumptions/conclusions. The technical documents referenced in the Henry Remedial Investigation Report (Henry RI Report) are included to provide additional relevant technical information from other locations within the P4 property boundaries or Southeastern Idaho Phosphate patch. They are used to support our positions/conclusions based on information collected from other nearby locations where the geology, hydrogeology, environmental setting and conditions, etc. are similar. Where necessary, information from previous studies has been added to the text for clarification.*

A/T Comment: Response OK

B. Overall, contaminants of concern (COC) in groundwater appear to be largely below maximum contaminant levels (MCL) and not migrating offsite. The COC concentrations also appear to be relatively stable, but respond to large snowmelt events (in particular, the above-average snowpack of 2011). However, data gaps in monitoring groundwater are identified in appropriate sections and on the drawings. The report contains numerous speculative statements such as "it is possible" or "probably flows" or "likely" or "either to the northwest or southeast." Statements such as these suggest to reviewers that questions, uncertainties, and data gaps still exist in the site characterization and undermine the conceptual site model (CSM). Revise statements to be more conclusive, or provide additional data or interpretation to eliminate the need for speculation. In addition, several specific comments note potential data gaps with respect to groundwater characterization, and raise questions about the adequacy of the well networks for determining groundwater flow direction and fate of contaminants. In addressing these comments, please identify uncertainties, discuss amount and type of information necessary to support remedial decision making, and identify potential data gaps that must be addressed at the RI stage of the process.

P4 Response (GC-B)*: These statements have been reviewed on a case-by-case basis and revised as needed. Because these are complex natural systems, there will always be some uncertainty. We have attempted to be more definitive and/or qualify the uncertainty where it is possible.*

A/T Comment: Response OK

C. In general, Appendix A of the report is well prepared and is likely to support future remedial decisions. However, it would benefit from revisions to reference the most current U.S.

Environmental Protection Agency (EPA) data sources and software. Although risk assessments generally default to protective assumptions to address unknown uncertainties, the toxicity values for arsenic and uranium are notable exceptions. For arsenic, the current cancer slope factor underestimates the risk of internal cancers, but a replacement value is not currently available. For uranium, the recent oral Minimal Risk Level (MRL) prepared by ATSDR is recommended as a superior alternative to the outdated IRIS Reference Dose (RfD) (see attached).

***P4 Response (GC-C)**: The cancer slope factor for arsenic is based on the current EPA value and, because no replacement value is available, this toxicity value was not changed in the revised document. Uncertainty associated with the evaluation of arsenic can be discussed in the uncertainty section of the BRA, as needed, following additional discussion on this topic with the USEPA reviewer.*

The uranium intermediate MRL (ATSDR, 2013) was available at the time the A/T instructed P4 to use the USEPA Office of Groundwater and Drinking Water (OGWDW) (2000) uranium RfD in October 2014. For consistency with prior direction from the A/T on a recommended RfD for uranium, and for consistency with the Ballard Site BRA, the RfD has not been updated.

A/T Comment: Revise to incorporate EPA recommendation to use ATSDR MRL https://semspub.epa.gov/work/HQ/196808.pdf

***P4 Supplemental Response:** As agreed during the comment resolution call between P4 and the A/Ts on April 24, 2017, the uranium oral reference dose (RfD) published in the USEPA's Integrated Risk Information System (IRIS) was replaced with the Minimum Risk Level (MRL) published in the Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profile for Uranium (ATSDR, 2013) and recommended in the USEPA memorandum entitled, Considering a Noncancer Oral Reference Dose for Uranium for Superfund Human Health Risk Assessments (USEPA, 2016).*

D. The EPA has recently released the 2016 Aquatic Life Ambient Water Quality Criterion for Selenium in Freshwater. This document provides chronic values for lotic, lentic waterbodies, and selenium in fish tissue whole body and egg/ovary, and reflects the best available science. Although these changes have not been adopted by the State of Idaho, they are Relevant and Appropriate Requirement [ARAR]). Please revise appropriate tables. In addition, EPA recently disapproved the State of Idaho's water quality criterion for Arsenic for the protection of human health. The relevant and appropriate requirement should be revised from 10 to 6.2 ug/l.

***P4 Response (GC-D)**: The text, tables, and drawings have been revised to incorporate the USEPA selenium and arsenic criteria. Please note that the reduction in both criteria will have little to no effect on the drawings and tables (e.g., only at MDS034 will the minimum value now exceed the arsenic criteria on Drawing 4-9). It certainly will not affect the risk assessment or nature and extent of findings as presented in the Henry RI Report.*

A/T Comment: Response OK

E. Volatile organic compounds (VOCs) are not in the list of COPCs for the Henry Mine Site and the human health conceptual site model (Figure 6-1) does not include inhalation as a route of exposure for groundwater. Thus, delete the VOC inhalation concentration column from tables in attachments B, C, D and E of Appendix A, or provide a rationale for using VOC inhalation concentration for groundwater exposure of future residents and future seasonal ranchers in the text and table notes.

***P4 Response (GC-E)**: The VOC concentration and VOC risk columns in the referenced tables are populated with "NA" consistent with the conceptual site model for this Site. However, for clarity, these columns have been removed.* **A/T Comment:** Response OK

F. Conclusions of Appendix A, as written, provide a good summary of the Baseline Risk Assessment (BRA). This section would benefit from emphasizing the objectives of the BRA, along with providing concluding statements regarding unacceptable risks associated with specific areas of Henry Mine Site, and major risk drivers for the Human Health Risk Assessment (HHRA), Ecological Risk Assessment (ERA), and Livestock Risk Assessment.

***P4 Response (GC-F)**: The BRA conclusions in Appendix A have been revised to restate the objectives of the BRA and identify the most significant risk drivers. A text discussion of specific areas of the Henry Site that are associated with excess risk is beyond the scope of the Henry Site BRA because the risk assessment only evaluated Site-wide EPCs. This request would be more easily accommodated in the FS for the Henry Site that will be prepared following acceptance of this RI document.*

A/T Comment: Response OK

G. Tables in Appendix A have some inconsistencies in the calculations of hazard quotients (HQ) and ecological hazard values. These calculations won't affect the final conclusions of the BRA; however, it would be good to revise all the calculations in the tables for accuracy and consistency in rounding decimals.

***P4 Response (GC-G)**: Inconsistencies result from displaying rounded numbers in formatted tables but carrying unrounded values through the calculation to the final HQ. Please refer to responses to SC-119 through SC-122.*

A/T Comment: Response OK

Specific Comments

Report

1. Section ES.4.1; Page ES-4; Paragraph 1 (partial); Sentence 3 (last)

Reword this sentence beginning "Depending on how the site …" as it reads awkwardly.

***P4 Response (SC-1)**: The sentence has been revised as follows: "Depending on Site conditions, water can continue downward through the mine dumps and infiltrate into the underlying shallow groundwater. This water then will be present either as seeps or springs further downslope, or as shallow alluvial groundwater plumes downgradient of the mine waste rock source areas."*

A/T Comment: Response OK

2. Section ES.4.1; Page ES-4; Paragraph 2; Sentence 4

Change to "Upland soil collected primarily from the soils developed on the graded and reclaimed waste rock dumps comprises …"

***P4 Response (SC-2)**: This edit has been made in the revised report.*

A/T Comment: Response OK

3. Section 1.2.2; Page 1-5; Henry Mining and Reclamation History, second paragraph, 5th sentence

Please clarify, does "As a result, most of the mine pits have been backfilled, graded to promote storm water drainage away from the pit backfill, and were covered and seeded to prevent erosion," mean that the storm water is draining into the pit or away from the pit? What does "away from" mean?

P4 Response (SC-3): *The sentence is intended to mean that storm water drainage is conveyed away from the backfilled and reclaimed mine pits. The sentence has been revised as follows: "As a result, most of the mine pits have been backfilled, graded to promote storm water drainage away from the backfilled mine pits and into intermittent drainages located down slope, then covered and seeded to prevent erosion."*

A/T Comment: Response OK

4. Section 2.5.2; Page 2-10; Vegetation, second bullet

This section describes milk-vetch as a Group 1-primary selenium accumulator species without discussing what Group 1 means, or directing the reader to a table with this information. Please revise for clarification.

P4 Response (SC-4)*: The bullet has been revised to reference NRC, 1983 listed below and the Soil and Vegetation Technical Memorandum (MWH, 2009) for the selenium accumulator species.*

National Academy of Science-National Research Council. 1983. Selenium in nutrition. Rev. ed. Board on Agric. NAS-NRC, Washington, DC.

A/T Comment: Response OK

5. Section 2.5.2, Page 2-10, last bullet

Reference where the list was obtained for which plant species were considered as culturally significant plants during the vegetation sampling/survey.

P4 Response (SC-5)*: The following text has been added to end of the first paragraph in Section 2.5.2: "Culturally significant plant species also were identified as part of the survey. The species list was provided by the A/T and documented in the A/T-approved sampling plan (Culturally Significant Plant Sampling Henry, Ballard, and Enoch Valley Mine Sites Late Summer/Fall 2009 Technical Memorandum [MWH, 2009b])."*

MWH, 2009b. Culturally Significant Plant Sampling Henry, Ballard, and Enoch Valley Mine Sites Late Summer/Fall 2009. Technical Memorandum to Mike Rowe, IDEQ, from Cary Foulk and Randy Walsh, MWH. August.

A/T Comment: Response OK

6. Section 2.6.1; Page 2-11; Regional Hydrogeology

Text states, "The alluvial groundwater typically is *unconfined* by lower permeability layers." Lower permeability layers typically confine groundwater? Check wording and revise if necessary.

P4 Response (SC-6)*: The sentence has been revised to simply say, "The uppermost alluvial groundwater typically is unconfined based on the boreholes and monitoring wells installed at the Site, and therefore, the water table surface and groundwater flow generally mirrors and follows the surface topography".*

A/T Comment: Response OK

7. Section 2.6.2.2; Page 2-19; Piezometric and Temperature monitoring

Text states "it is possible there is increased loss from the river to the Wells Formation during high flow events, and this is an area of significant recharge…." This is a potential data gap. To confirm or refute this assertion, streamflow measurements up and down from where the Little Blackfoot River (LBFR) crosses the Wells Formation could be conducted. If the LBFR creates significant recharge to the Wells

Formation, and the river becomes impacted by COCs, then this is an important component of the CSM that must be addressed.

P4 Response (SC-7)*: There are several points to consider. First, flow measurements may not have the resolution to see the flow loss, especially during high-flow events because the potential measurement error is often relatively large. Second, COC/COEC concentrations in this area along the LBFR have rarely exceeded screening criteria for either surface water or groundwater. The surface water screening level for selenium has been exceeded at the surface water sampling station MST044, but in only 2 of 14 events did selenium concentrations in the river exceed the surface water screening criteria (0.0031 mg/L), and the groundwater selenium MCL (0.05 mg/L) has never been exceeded in the river. Third, selenium and other COC/COEC concentrations in the river are not trending upward, and there is no reason to suspect they will be given that the Henry Mine is reclaimed and closed over large areas. Finally, the piezometric hydrograph for MMW011, especially in association with high flow events, is indicative of the recharge, and for this reason the sentence in question has been revised to say:*

"The Little Blackfoot River crosses the Wells Formation near MMW011, and the hydrograph from this monitoring well indicates increased loss from the river to the Wells Formation especially during high flow events. This portion of the river corridor is believed to be an area of recharge to the formation."

A/T Comment: Response OK

8. Section 2.6.2. 2; Page 2-19; Piezometric and Temperature monitoring

a. Text states "MWs MMW011 and MMW023 are on the *conceptual* flow line in the Wells Formation that is *assumed* to terminate at the Henry Springs…" [italics added]. Two wells with 10 feet of water level difference do not necessarily define a groundwater flow direction. An apparent gradient to the north does not mean the groundwater flows north; just that there is a possible northward component of overall flow. Data from nearby mine sites indicates that the gradient and flow direction in the Wells Formation is generally more to the west. Defining the flow direction and gradient in the Wells Formation is an important part of the Site Characterization and CSM. See also 2010 technical memorandum on this topic that was re-circulated recently.

b. Was, or is, the Henry Spring being sampled or monitored? Has the discharge from this spring been chemically "typed" and compared with Wells Formation water? Have site COCs been detected? Please provide data. If this spring is downgradient from the site and discharges Wells Formation groundwater, data from this spring are important to the CSM and COC Fate and Transport (F&T).

P4 Response (SC-8)*:*

a) The concept of westward flow in The 2010 A/T technical memorandum (2010 tech memo), was discussed and commented on during the scoping and development of the <u>Final Remedial Investigation/Feasibility Study Work Plans for P4's Ballard, Henry and Enoch Valley Mines (RI/FS Work Plan; MWH, 2011)</u>. We also have attached the response to the 2010 A/T Tech Memo that was prepared by Dr. Dale Ralston, P.G., P.E., Professor Emeritus of Hydrogeology, University of Idaho. Dr. Ralston has researched and published many scientific papers on groundwater flow in SE Idaho. The hydrogeologic condition of the regional aquifer also is summarized in Section 5.1.4.3 of this <u>Henry RI Report</u>, and is discussed in more detail in the <u>RI/FS Work Plan</u>, notably Section 3.7.4.3 and associated comments and responses in Appendix F.

As summarized by Dr. Ralston in his response to the A/Ts' 2010 Tech Memo, regional flow patterns cannot be determined based on widely-spaced potentiometric measurements in the structurally and lithologically complex geologic terrain of SE Idaho as suggested by the 2010 A/T Tech Memo (i.e., *piezometric measurements separated by major geologic and geographic features cannot be used to project local groundwater flow patterns). The groundwater flow in the regional aquifer at the Site is in Wells Formation (refer to the Drawing 2-2 and Section B-B' geologic map), which is on a steeply dipping limb of a syncline oriented along a northwestern/southeastern line. The groundwater flow relevant to the Site is in poorly cemented sandstone units of the upper Wells Formation. Significant westward flow in the Wells Formation at the Site is very unlikely as this would be across bedding, which would necessitate groundwater movement through lower permeability limestone beds of the Wells Formation. Groundwater flow is similarly restricted in an eastward direction by the low permeability Meade Peak Member of the Phosphoria Formation. Thrust faults to the east and west also bound and compartmentalize the regional groundwater flow system.*

Flow to the northwest in the Site area was first put forth in by Dr. Ralston in 1983 (Ralston, et. al., 1983). The presence of the Henry Springs (nearby to the northwest – Drawing 2-1) is strong evidence of northwest flow in the regional aquifer within the hydrogeologic block bounded by the roughly parallel Henry Thrust and the Slug Valley Faults (refer to Drawing 2-2). The Henry Springs are a recognized regional discharge point for the Wells Formation and the regional aquifer (Mayo. 1982; Ralston, et. al. 1983). This northwestern flow direction is further supported by potentiometric measurements collected during the P4 RI from MMW011 and MMW023 that indicate a northwest flow gradient in the uppermost Wells Formation sandstones at the Site (Drawing 2-2 also shows the locations of these monitoring wells). These potentiometric measurements are collected from the upper beds of the Wells Formation on the western syncline limb (i.e., in a continuous hydrostratigraphic unit). Flow to the southeast in the Wells Formation is impeded by the east-west trending Rasmussen Fault (refer to Drawing 2-2) along the southeastern margin of the Site.

Finally, any monitoring well or piezometer installed at a reasonable depth perpendicular to the line between MMW011 and MMW023 would be in steeply dipping hydrogeologic units either up or down the geologic section as shown in Drawing 2-2 and possibly separated by a steeply dipping aquitard, such as the Meade Peak Member of the Phosphoria Formation or lower permeability beds of the Wells Formation. Any piezometric (water level) measurements from these locations would not be indicative of the groundwater flow in the upper sandstone beds of the Wells Formation that are most likely to be affected by the Site.

b) The Henry Springs and the regional aquifer are discussed in Mayo (1982) and Ralston, et. al. (1983). They were not sampled as part of the P4 RI/FS investigations and COC data are not available although general water quality are available in Mayo (1982). However, note that MDW005 is installed in the same area as the Henry Springs and has been sampled for water chemistry and COCs during the P4 RI. Data from MDW005 have been included in the revised <u>Henry RI Report</u> and based on general water quality appears to be similar to the springs. Mayo (1982) dates the water discharging from the springs are in excess of 10,000 years old (i.e., 20,500 years old). However, this is an average age, and discharging spring water may include younger and older contributions. This older date suggests that if any Site water were to have reached the springs, significant dilution and attenuation undoubtedly would have occurred. Any signature or COCs from the Site are not likely to be distinguishable in the discharge because of this dilution (discharge from the springs was approximately 5,000 gpm in 1980 [Ralston et. al., 1983]). The sampling reported in Mayo (1982), and discussed further in Ralston, et. al. (1983), verifies that the water discharging at the Henry Springs is regional aquifer water, of which the Wells Formation is the major component. Other deeper limestone units (Brazer and Madison Limestones) may also contribute some flow. The following discussion has been added to the end of Section 2.6.2.2:

> *"The Henry Springs discharge at an elevation approximately 6,135 feet AMSL, or approximately 20 feet lower than the water level in MMW023. They have formed a large area of travertine located approximately 1 mile west of the northern portion of the Site (Drawing 2-2). The springs and associated flow system were sampled and evaluated by Mayo (1982) and Ralston, et al. (1983). Sampling for the major ions indicate that the water discharging from the springs is a highly evolved calcium-carbonate water type discharging from the Wells Formation. The sulfate content of the springs is low, averaging approximately 50 mg/L. The water discharging from one of the springs was dated at 20,500 years old (Mayo, 1982). The flow volume (> 4,000 gpm), chemistry, and age date indicate this is groundwater discharge from a large portion of the Wells Formation (which represents a large area) and other regional aquifer formations."*

A/T Comment: 1) Thank you for including Dr. Ralston's response to the A/T's 2010 TM on Regional Flow Patterns. As part of his response, Ralston also suggests "Recommended Next Steps". It is assumed that P4 followed-up on these recommendations as a means of completing the hydrogeologic characterization of the Henry Mine site. Please identify where this information resides in the RI, particularly information associated with bullets 3 and 4, which would clarify concerns about flow direction in the Wells formation within the confines of the geologic "compartment" underlying the Henry Mine site.

2) If the Henry Spring is the discharge point for the regional aquifer, and it is downgradient of the Henry Mine, we recommend the spring be sampled to confirm the water type and that water quality is free of COCs and consistent with the last known date of sampling 1982. In active seismic areas, geologic structures dictating the hydrogeology and contaminant fate and transport are known to change over time. The last sampling was 34 years ago. The water quality of Domestic Well MDW005 (sampled 3 times) was offered as a surrogate of water quality in the regional aquifer, but this well is identified in Drawing 3-3 of the RI as a "Local aquifer monitoring well (generally alluvial system)" [total depth of 46 ft]. As such, and given its proximity to the Blackfoot River and Reservoir, it's water quality likely reflects these features as they interact with the local aquifer, whereas the Henry Springs should reflect water quality of the regional aquifer.

P4 Supplemental Response (SC-8):

1) *In response to Dr. Ralston's recommendations listed below, the following has been considered.*

- *Dr. Ralston Bullet 1 - The well locations should be shown on a map that shows all of the major structural features (folds and faults) including strike and dip information where possible. The map should be on a scale that is sufficient to allow inclusion of the six mine sites considered in the document under review plus additional nearby mines (i.e. Dry Valley, Wooly Valley…) where Wells Formation ground-water data are available. The water-level elevation should be written near each well location. Contour lines of the equal water-level elevation should not be constructed.*
    - *It also should be noted that the memorandum was prepared in consideration of all three of the P4 legacy sites, Ballard, Henry and Enoch Valley. Given the relatively simple geology of the Henry Mine, compared to Ballard, for example, the hydrogeologic presentation of the Henry Mine was not as complex. In addition, because the Henry Mine is contained in a block of bedrock bound by the Henry Thrust Fault, the Slug Valley Fault, and the Rasmussen Fault, the relevance of water levels outside of the Henry block were uncertain. Therefore, the more area-wide piezometric presentation was not carried forward. However, in consideration of the recommendations, it makes sense to*

add flow arrows and water level information to the geologic map for the bedrock units (Drawing 2-2). This provides the underlying geologic and structural basis for the conceptual model. Reference to the drawing was added in the appropriate discussions in the text.

- *Dr Ralston Bullet 2 - Text should accompany the map that describes the CSM for each mine site within the context of structurally controlled subareas within the regional aquifer. The plan-view map should show the subarea boundaries.*
    - *Text for the each P4 Site's CSM was incorporated into the RI/FS Work Plan and the Ballard and Henry RI Reports.*
- *Dr. Ralston Bullet 3 - To the extent possible, generalized flow lines should be shown on the map for each of the P4 Mines. The flow lines should be based on controls of groundwater flow posed by geologic features (folds and faults) and water-level elevation data from wells.*
    - *As mentioned in bullet #1 above, generalized flow arrows were added to Drawing 2-2 in the revised Henry RI Report.*
- *Dr. Ralston Bullet 4 - The data gap analysis should be based on analysis of locations and depths of existing wells in comparison to the generalized flow lines shown on the map for each mine site. New wells would be recommended only if needed to add detail for the CSM for a given mine site.*
    - *Dr. Ralston was involved in scoping the EE/CA investigations and his 2010 memorandum was a key consideration when assessing data gaps for the RI/FS Work Plan. The data needs highlighted by Dr. Ralston were initially discussed with the A/T during a RI/FS data gap and scoping presentation meeting at the IDEQ offices on March 3, 2010. Dr. Ralston's memorandum was in response to the discussions that began in that March meeting and which were resolved to the A/Ts satisfaction prior to the July 2010 work plan submittal.*

2) P4 proposes to conduct field reconnaissance of the regional spring locations, evaluate the locations, then with EPA approval sample up to three spring locations in the Henry Springs area during spring/summer 2017. The locations to be evaluated and then selected will be from areas along the Little Blackfoot River, closest to the Henry Mine and the location that corresponds to the spring sampled by Dr. Ralston north of the town of Henry. The spring samples will be analyzed for general chemistry parameters and metals/metalloids and the data will be presented in the 2017 DSR and incorporated in the Henry FS evaluation.

9. Section 2.7; Page 2-21; Paragraph 2 (last); Line 7-8

Use of the term leeward is usually associated with wind. Use direction (for example, north and east) or indicate the prevailing wind direction at the site. Please clarify.

P4 Response (SC-9)*: The sentence has been revised as follows: "Forested land (dominantly conifers) is primarily located near the southern end of the Site."*

A/T Comment: Response OK

10. Section 2.9; Page 2-23; Paragraph 5 (last); Sentence 4

Confirm the date on the establishment of the Fort Hall Reservation, as 1863 would be 5 years prior to the signing of the treaty in 1868.

> ***P4 Response (SC-10)****: The date has been changed to 1868 in the revised report. Although note there are online references cite the date back to the original 1863 date as provided in the websites below.*
>
> http://www.sbtribes-ewmp.com/land_base_fort_hall.html
>
> http://www.nrcprograms.org/site/PageServer?pagename=airc_res_id_forthall
>
> **A/T Comment:** Response OK

11. Section 2.10.1; Page 2-24; Phosphoria Formation, first paragraph:

The discussion indicates that there are "naturally elevated background concentrations that result in elevated concentrations of some elements downslope of Meade Peak outcrops in soils and also likely in stream sediment, and possibly downgradient in groundwater and surface water." According to the tables provided in the P4 Background Tech Memo FINAL-Rev 0_March 2013, none of the sediment, surface water or groundwater samples exceeded the screening level for selenium, the site driver. The only elevated selenium samples this reader observed in the background data was for approximately eight soil samples. It appears that the statement made is unsupported by the data, and should be re-phrased to specify which elements you are considering in the statement; bring in the data from the background tech memo for the reader to review.

> ***P4 Response (SC-11)****: Upland soil background samples initially collected during the RI, as presented in the Background Levels Development Technical Memorandum (2013 Background Levels Tech Memo; MWH, 2013), represent only a portion of the potential area disturbed by the historic mining operations, and did not include soils derived from, and overlying, the Phosphoria Formation. A supplemental soil background study was performed in fall 2014 as detailed in the On-Site and Background Areas Radiological and Soil Investigation Summary Report (2015 Background and Radiological Report, MWH, 2015).*
>
> *The 2014 background samples were collected from upland soils overlying the three primary geologic formations including the Phosphoria Formation (Meade Peak and Rex Chert Members) at an undisturbed or natural portion of the Blackfoot Bridge Mine and at Caldwell Canyon. These data were combined with the 2009 upland soil background sampling to develop representative background values for upland soils. The reviewer should become familiar with this study and its findings as the upland soil background concentrations collected in 2014 from the Phosphoria Formation are elevated in several constituents. The resulting 2015 95-95% UTL values for individual COCs/COECs (used for upland soils screening) range from approximately 1.5 to 200 times higher than the 2013 95% USL upland soil background values as shown in the table below.*
>
> *As noted in the Henry RI Report and the 2015 Background and Radiological Report, representative background samples for sediment, riparian soil/vegetation, surface water, and groundwater have not been collected from native areas downslope/downstream of the Phosphoria Formation. Based on the elevated upland soil constituents detected in 2014, it is plausible that background samples collected downslope/downstream of undisturbed/native pre-mined Phosphoria Formation would result in elevated concentrations in these media as well.*

Upland Soil	2013 Background Value (95% USL)	2015 Background Value (95-95 UTL)	Factor Increase
Antimony	0.745	**3.60**	4.8
Arsenic	11.5	**15.6**	1.4
Cadmium	8.6	**41.0**	4.8
Chromium	32.7	**410**	12.5
Copper	37.5	**51.9**	1.4
Molybdenum	3.45	**29.0**	8.4
Nickel	37.8	**220**	5.8
Radium-226	NA	**15.1**	NA
Selenium	1.80	**29.0**	16.1
Thallium	0.288	**1.10**	3.8
Uranium	1.61	**36.0**	22.3
Vanadium	1.61	**300**	185.9
Zinc	173	**1,200**	6.9

A/T Comment: Re-phrase to clarify that statements related to COCs "likely" or "possibly" being elevated in background sediment, groundwater and surface water are hypotheses that have not been tested, and are therefore speculative.

P4 Supplemental Response: *The sentence in Section 2.10.1, page 2-24, has been revised as follows: "These naturally elevated background concentrations result in elevated concentrations of some elements downslope of Meade Peak outcrops in soil and it is hypothesized that concentrations may be elevated ~~also likely~~ in stream sediment, and possibly downgradient groundwater and surface water (MWH, 2015b)."*

12. Section 2.10.1; Page 2-24; Paragraph 3; Line 4

This sentence implies that all constituents are elevated in soils overlying undisturbed and pre-mined areas of Meade Peak Member. If memory serves, background concentrations at Caldwell Canyon did not differ much from background concentrations observed at other formation/member outcrops (Dinwoody, Wells). Insert a qualifier in this sentence; perhaps, "Please note that for some undisturbed and pre-mined areas …"

P4 Response (SC-12)*: The sentence was not meant to imply that all constituents are elevated in soil overlying undisturbed and pre-mined areas of the Meade Peak Member. P4 refers the reviewer to Table 3-11 from the 2015 Background and Radiological Report (MWH, 2015), which shows at both Caldwell Canyon and Blackfoot Bridge that a majority of the COCs/COECs including cadmium, chromium, copper, molybdenum, nickel, selenium, thallium, vanadium, uranium, zinc, and radium-226 reported the highest concentrations in the soil samples collected from the Phosphoria Formation (primarily the Meade Peak Member). Based on these 2015 findings, no revision to this sentence is necessary.*

A/T Comment: Response OK

13. Section 2.10.1; Page 2-25; Phosphoria Formation

Rather than referring to another report, please provide a summary table that shows elemental concentrations in the Meade Peak Member to assist in comparisons.

If background concentrations are naturally elevated, please cite the document reporting this information, provide a summary of background concentrations, and identify COCs that are truly elevated as a result of activities at the Henry Mine.

> ***P4 Response (SC-13)**: The report has been revised to include a summary of the elemental concentrations in the Meade Peak Member. This will include a version of Table 2-7 included in the Final Ballard RI Report (November 2014).*
>
> *As discussed in response to SC-11 above, elevated background concentrations in soils overlying the Phosphoria Formation are well documented in the 2015 Background and Radiological Report (MWH, 2015), which is referenced twice in Section 2.10.1. Upland soil background concentrations and a summary of elevated COCs/COECs are provide in Table 4-1, as well as Appendix B Table B-1a, and are discussed in Section 4.1.*
>
> **A/T Comment:** Response OK

14. Section 2.10.2; Page 2-28; Paragraph 1 (partial); Sentence 2 (last)

Explain why data from South Rasmussen Mine (SRM), in particular, will be useful for establishing hydrogeologic characteristics for a location with uncovered center waste shale. The area of study at SRM is a waste rock dump that is covered.

> ***P4 Response (SC-14)**: Note that O'Kane started monitoring an area of uncovered CWS on the Horseshoe Overburden Facility at South Rasmussen in 2008. However, the last paragraph of Section 2.10.2, pages 2-27 and 2-28 has been revised as follows: "In 2007 and 2009, site locations were instrumented with a network of moisture sensors (e.g., time domain reflectometry or TDR sensors) including P4's South Rasmussen Mine. Data from this site and the other sites monitored by O'Kane Consultants (O'Kane, 2009a and 2009b) may be useful in establishing hydrologic characteristics of various cover configurations that occur at the three P4 Sites, including various thicknesses of soil and rock cover."*
>
> **A/T Comment:** Response OK

15. Section 3.5; Page 3-4

There is a potential data gap in surface water sampling locations along the Little Blackfoot River, between MST044 to the confluence with Long Valley Creek/Long Valley Creek Tributary.

> ***P4 Response (SC-15)**: P4 does not believe there is a characterization data gap for surface water along this segment of the Little Blackfoot River (LBFR) because are no sources of P4 contamination that would affect the LBFR downstream of the MST044 monitoring station. Additionally, both monitoring wells MMW011 (Wells Formation) and MMW019 (Alluvial/Phosphoria Formation) located further downstream (i.e., west of MST044) and near the LBFR are not impacted.*
>
> **A/T Comment:** Response OK

16. Section 4.1.3; Page 4-5; Paragraph 3; Sentence 3

Change to "However, as seen on Table 4-1, most of concentrations are within about two times the background level."

***P4 Response (SC-16)**: Agreed. The revised RI report contains this change.*

A/T Comment: Response OK

17. Section 4.1.4.2; Page 4-7; Paragraph 3; Sentence 4

Delete "with a mean of 4.04pCI/m^2-s," as it is mentioned in the following sentence.

***P4 Response (SC-17)**: Agreed. This change has been made in the revised report.*

A/T Comment: Response OK

18. Section 4.2.6; Page 4-14; Paragraph 1

If it was "not possible to segregate riparian vegetation results by plant species," how were preliminary COC concentrations in culturally significant riparian vegetation measured? Discuss.

***P4 Response (SC-18)**: As discussed in Section 4.2.6, riparian vegetation was sampled and analyzed for a suite of five constituents of concern (i.e., cadmium, copper, molybdenum, selenium, and zinc). The BRA in Appendix A, Sections 3.3.2.1 and 3.3.2.2 states that measured riparian vegetation data were used in the risk assessment calculations for aquatic culturally significant plants, where available. When plant tissue data were unavailable (i.e., not one the five COCs listed above), the plant tissue concentrations of individual constituents (e.g., vanadium) were modeled based on uptake from soil and sediment.*

A/T Comment: Response OK

19. Section 4.3.4.1; Page 4-20; Paragraph 4; Sentence 4

The sentence says, "While these concentrations [for sediment] are notable, they have little relevance to the Site as they are not associated with the Site nor were they considered background." Yet, two paragraphs previous for riparian soil, "Because these stations were identified as being associated with the Site and not background locations, they were included in the risk calculations for the Site (see Section 6.0)." Explain this seeming discrepancy.

***P4 Response (SC-19)**: As discussed under "Other Stations" in Section 4.3.4.1, "These stations, MST058, MST226 and MST275, were assigned as Site surface water stations, because they are located on tributaries of the Lone Pine Creek drainage, for which, the Henry Site is the dominant feature in the watershed (Drawing 4-8)." They also provide data for conditions in the entirety of Lone Pine Creek including its headwaters (east and west drainages). As a result, these locations were used in the BRA. The sentence initially referred to in this comment has been removed.*

A/T Comment: Response OK

20. Section 4.4, Page 4-3, Paragraph 1, Sentence 1

This sentence states that "selenium is the most common contaminant detected at the site." Tables A2-1 through A2-7 show that selenium in not the most common contaminant detected in any medium. The sentence should be revised.

***P4 Response (SC-20)**: Note that this sentence is on Page 4-23. It has been revised as follows: "Selenium is the most common contaminant detected above its individual surface water screening criteria."*

A/T Comment: Response OK

21. Section 4.4, Page 4-3, Paragraph, Sentence 2

This sentence is not accurate as EPA released new federal water quality criteria for selenium in June 2016 that no longer supports the previous 0.005 milligram per Liter (mg/L) chronic criterion. The current federal water quality criteria (WQC) document recommends water-based lentic and lotic values of 1.5 and 3.1 micrograms per Liter (µg/L), respectively, along with tissue-based. Revisions to the text are necessary to acknowledge the updated federal criteria for selenium.

> ***P4 Response (SC-21)**: See response to GC-D. The document has been revised to reference the updated criteria for selenium.*
>
> **A/T Comment:** Response OK

22. Section 4.4.1; Page 4-23; Preliminary Contaminants of Concern…, last paragraph and page 4-24 first paragraph and elsewhere in the document

Delete the word "slightly" where it describes sampling from the sentences where exceedances are spoken about (and elsewhere in the document) as this term is subjective. A constituent either exceeds or does not exceed screening criteria. Modify as necessary to describe the magnitude of exceedance.

> ***P4 Response (SC-22)**: The word "slightly" has been globally searched and replaced or qualified with an order of magnitude of percentage unit of measure throughout the revised report.*
>
> **A/T Comment:** Response OK

23. Section 4.4.2; Page 4-26; Paragraph 2; Sentence 5

Change: "This pond is typically dry in the fall (Figure 4-7)," to "This pond is typically dry in the fall (note the absence of sampling data in the fall on Figure 4-7)."

> ***P4 Response (SC-23)**: Agreed. This change has been made in the revised report.*
>
> **A/T Comment:** Response OK

24. Section 4.4.3; Page 4-27; Paragraph 3 (last); Sentence 3

Delete "slightly" (too subjective, especially when concentrations are two and three times the criterion) and change to "exceed" (for subject-verb agreement) to read "… MDS016 (0.018 mg/L) exceeds the screening criteria, and two of three samples from MSG002 (0.012 and 0.016 mg/L) exceed the screening criteria."

> ***P4 Response (SC-24)**: Agreed. The word "slightly" has been replaced in the revised report as noted in the response to SC-22.*
>
> **A/T Comment:** Response OK

25. Section 4.4.3; Page 4-28; Paragraph 2; Sentence 1

Only one of six concentrations in Table 4-10 for arsenic were reported at the method detection limit (MDL). Revise.

> ***P4 Response (SC-25)**: Agreed. Section 4.4.3, Page 4-28, Paragraph 2 has been revised as follows: "The measured concentrations of cadmium (key preliminary COC/COEC) in the seeps and spring are typically reported at the MDL (e.g., <0.0001 mg/L) as shown in Table 4-10 with a maximum cadmium concentration of 0.0008 mg/L in MDS016 (spring 2006). Arsenic concentrations ranged from <0.0005 mg/L in MDS022 (spring 2006) to 0.0079 mg/L in MDS034 (spring 2008). These cadmium and arsenic concentrations are below their screening criteria."* **A/T Comment:** Response OK

26. Section 4.4.3; Page 4-28; Paragraph 2; Sentence 2

Based on Table 4-10, it looks like the maximum arsenic concentration should be 0.0079 mg/L in MDS034 in Spring 2008. Revise.

> ***P4 Response (SC-26)**: Agreed. This maximum arsenic concentration has been changed in the revised report. See response to SC-25.*
>
> **A/T Comment:** Response OK

27. Section 4.4.4.1, Page 4-28, last paragraph, Sentence 3

Dilution is one of several processes for which attenuation may occur. Revise the sentence to read "… through attenuation (e.g, dilution)."

> ***P4 Response (SC-27)**: Section 4.4.4.1, Page 4-28, last paragraph, Sentence 3, has been revised to read "…. through attenuation (e.g., dilution, sorption, or redox reactions)."*
>
> **A/T Comment:** Response OK

28. Section 4.4.4.1; Page 4-30; Bullet 3

Shouldn't the value 0.0011 mg/L be included in the MST276 box on Drawing 4-10 where the three samples shown were all nondetects? Revise accordingly.

> ***P4 Response (SC-28)**: The concentration of 0.0011 mg/L at MST276 was based on a total concentration. For surface water, dissolved concentrations were used for comparison to screening criteria and to develop the summary statistics reported on Drawings 4-9 and 4-10. The exception to this is selenium, where the standard and data are based on total concentration. This will be indicated on Drawings 4-9 and 4-10 and noted in the text. The bullets on Page 4-30, Section 4.4.4.1 have been revised to indicate dissolved or total concentrations.*
>
> **A/T Comment:** Response OK

29. Section 4.4.4.1; Page 4-31; Paragraph 2; Line 1

According to the MST275 box in Drawing 4-10, the minimum should be less than 0.001 mg/L. Revise accordingly.

> ***P4 Response (SC-29)**: The text is correct. As shown in Appendix B Table B-6b, the lowest detection limit for total selenium at MST275 is 0.0005 mg/L. The minimum value in Drawing 4-10 was incorrectly rounded and has been changed on the drawing in the revised report to 0.0005 mg/L.*
>
> **A/T Comment:** Response OK

30. Section 4.4.4.1; Page 4-31; Paragraph 2; Line 3

According to the MST275 box in Drawing 4-10 the minimum should be 0.0005 mg/L. Revise accordingly.

> ***P4 Response (SC-30)**: This change has been made in the revised report.*
>
> **A/T Comment:** Response OK

31. Section 4.4.4.2; Page 4-32; Little Blackfoot River

Figures 4-10 and 4-11 do not show sampling results for 2011. Was sampling performed in 2011? If so, please include this information. If not, please include a comment as to why sampling was not performed.

***P4 Response (SC-31)**: Sampling was not performed in 2011. A note has been added to Figures 4-10 and 4-11 in the revised report.*

A/T Comment: Response OK

32. Section 4.4.4.2; Page 4-32; Little Blackfoot River

There appears to be a data gap in surface water sampling locations along the Little Blackfoot River, between MST044 to the confluence with Long Valley Creek/Long Valley Creek Tributary.

***P4 Response (SC-32)**: See the response to SC-15.*

A/T Comment: Response OK

33. Section 4.5.2; Page 4-36; Hydrostratigraphy Units

Describe the sampling results of the Monsanto agricultural wells (MAWs) and Monsanto Domestic Wells (MDWs).

***P4 Response (SC-33)**: A summary of the historical ground water COC sampling results has been included in new table in Section 4.5 in the revised draft.*

A/T Comment: Response OK

34. Section 4.5.2; Page 4-36; Paragraph 6 (last); Sentence 1

Where are total dissolved solids (TDS) concentrations shown on Drawing 4-11? Revise accordingly.

***P4 Response (SC-34)**: Reference to TDS has been removed from the sentence.*

A/T Comment: Response OK

35. Section 4.5.2.1; Page 4-38; Shallow Alluvial Unit

a. Does the water in the alluvial aquifer flow downward to lower bedrock units? If alluvial groundwater is or becomes impacted and flows into deeper aquifers, the CSM needs to reflect this possibility. Evaluate vertical groundwater gradients.

b. Text states, "Surface water flow is *presumed* to be directed westward. (1) Should this be "*Groundwater* flow …." (2) Part of site characterization and developing the CSM is to identify the groundwater flow direction; not *presume* where it is directed.

c. From the western mouth of the canyon, the LBFR flows to its confluence with Long Valley Creek and then northwest toward the Blackfoot Reservoir; the site geology map (Drawing 2-2) indicates a ribbon of alluvium. However, no direct push borings or alluvial wells are located along this corridor (Drawing 3-3; 4-11). This is the direction of surface water flow, downgradient of the mine site, and likely shallow groundwater flow in the alluvium, based on the topography. Does shallow groundwater data exist for this area or does this represent a potential data gap?

***P4 Response (SC-35)**:*

a. Vertical gradients were not extensively evaluated during the RI or in this Henry RI Report because of the general lack of alluvial groundwater concentrations exceeding the regulatory screening levels (refer to Drawing 4-11). The most notable exception is the monitoring well MMW010 location. The nearest bedrock well is MPW023 located approximately 750 feet to the southeast in Phosphoria Formation, and COC concentrations do not exceed screening levels in this well. This suggests that downward migration into the bedrock at this location is not occurring despite an apparent slight downward gradient indicated by comparisons of MMW010 and MPW023 water *level measurements. Both wells are installed in mining disturbed areas, and adjacent to a backfilled mine pit. This discussion has been added to Section 4.5.2.1 in the MMW010 presentation.*

A/T Comment: Response OK

b. *Fundamental to the discussion of flow in the alluvial (including colluvium) system is the recognition that these deposits form a thin veneer of clay, sand and gravel deposited over the bedrock. Where encountered, groundwater is typically between 0 and 20 feet below the ground surface. The relief on the hillsides is on the order of 100's of feet, so in most cases, the water table mirrors the topography. The exception at the Site is along the Little Blackfoot River and upper reaches of Lone Pine Creek that may locally be underlain by thicker alluvium. However, in the upland areas it is the topography and drainage locations that dictate the direction of shallow groundwater flow, which is similar to surface water flow. The sentence in question was rewritten as follows – "Groundwater flow locally, in the thin alluvial deposits, is directed westward toward the Little Blackfoot River following the topography and the local drainage, and roughly parallels the alignment of the three boreholes in this area."*

A/T Comment: Response OK

c. *Because of the general absence of COC concentrations in surface water or groundwater exceeding groundwater screening levels, downgradient investigation of alluvial groundwater near the confluence of Long Valley Creek was not conducted. This area is approximately 4,000 feet downstream of the Site, and is not considered a data gap. Please see response SC-15 regarding additional surface water investigation in this same area.*

A/T Comment: Response OK

36. Section 4.5.2.1; Page 4-40; Shallow Alluvial Unit

Explain the cadmium results in MMW004 and other wells. Describe the less-than-0.1 (non)detect (above MCL, but below detection limit) (see Drawing 4-11).

***P4 Response (SC-36)**: Cadmium is discussed where it exceeds its screening criteria (i.e., its MCL) which is limited to monitor well MMW010. A single sampling event in October 2005 resulted in a cadmium method detection limit (MDL) above the MCL that affected samples from two wells (MMW004 and MPW022). These wells have several other non-detect results at an MDL below the screening level. This isolated occurrence of a higher MDL does not warrant additional discussion in the text, although, a footnote has been added to the text in this location.*

A/T Comment: Response OK

37. Section 4.5.2.1; Page 4-41; Shallow Alluvial Unit

Text states that alluvium was investigated using "….two monitoring wells." Explain how flow direction is calculated from only two monitoring wells.

***P4 Response (SC-37)**: We are unclear as to where on page 4-41 the comment is referencing. The discussion on page 4-41 primarily addresses analytical results from MMW004 and MMW019.*

Both of these wells lie between waste rock dumps and the Little Blackfoot River, and the purpose of these wells is to sample and analyze the groundwater next to the source areas for contamination. As discussed in response SC-35, it is a reasonable assumption in the alluvial system that groundwater flows from the recharge areas on the hillsides toward topographic low points, in this case the LBFR. That places both wells downgradient of major waste rock deposits (i.e., source areas), which was the *objective of the investigation. These wells are on either side of the river, and they are not directly related. In addition, as stated in Section 4.5.2.1, the northern alluvial area was investigated by 14 direct-push boreholes including one that became borehole well MBW152, as well as MMW019 and MMW004. These wells and borings were used to evaluate groundwater flow directions. No revisions to the text are recommended.*

A/T Comment: Response OK

38. Section 4.5.2.1; Page 4-42; Shallow Alluvial Unit; Paragraph 5 (last); Line 6

Text states, "This drainage was investigated with three boreholes (BH072, BH076, and BH079)." Should 076 be 078? Revise accordingly.

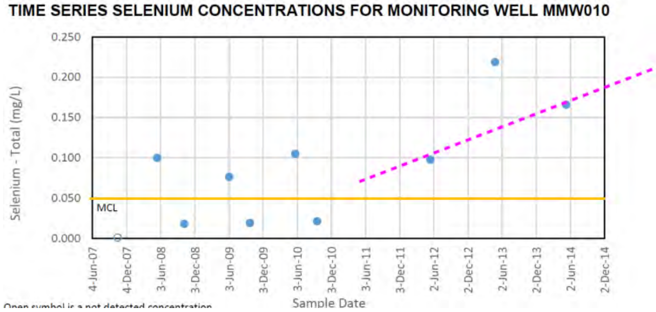
P4 Response (SC-38)*: The text has been corrected to "(BH072, BH078, and BH079)".*

A/T Comment: Response OK

39. Section 4.5.2.1; Page 4-43; Shallow Alluvial Unit, Figure 4-15

Text states "Selenium concentrations in MMW010 exceed the criteria of 0.05 every spring…and all fall results are below 0.05 mg/L." According to Figure 4-15, no fall samples are available after 2010, and since 2011 the springtime samples have increased and are as high as 0.219 mg/L. Fall samples could very well be above the MCL by now. Either provide fall samples, or modify statement to say that no fall samples have been collected since 2010, and the 2013 and 2014 samples are historic highs.

FIGURE 4-15
TIME SERIES SELENIUM CONCENTRATIONS FOR MONITORING WELL MMW010



P4 Response (SC-39)*: The sentence has been revised to say, "Selenium concentrations in MMW010 exceed the criteria of 0.05 mg/L every spring with concentrations up to 0.219 mg/L, and all the fall results were below 0.05 mg/L when they measured prior to 2011 (****Figure 4-15****)." P4 does not intend on adding 2015 concentrations to the Henry RI Report (these are reported in the associated 2015 DSR). However, the spring 2015 total selenium concentration in MM010 was 0.119 mg/L (more in line with the pre-2013 concentrations).*

A/T Comment: Response OK

40. Section 4.5.2.2; Page 4-45; Dinwoody Formation

a. Text states "Constituents from the Site could migrate northeastward perpendicular to the syncline axis toward the Henry Thrust Fault, or parallel to the axis of the syncline toward the northwest." The goal of a site characterization/RI is to determine with confidence which way the water flows and thus evaluate where the COCs may migrate – please provide rationale for this statement, or additional discussion.

b. Text states that two monitoring wells were installed to evaluate these flow paths – two monitoring wells do not appear to be adequate to enable characterizing the flow direction and gradient in the Dinwoody formation. Please clarify and resolve.

***P4 Response (SC-40)**:*

a) In the case of the Dinwoody Formation, COCs detected in groundwater contained therein do not exceed their respective screening levels near the source of contamination (where they should be the highest). Therefore, the need for further investigation was dismissed for reasons presented below.

Groundwater collected from monitoring well, MMW022, (installed through the edge of the waste rock dump and into the Dinwoody Formation aquifer), does not exceed screening levels for COCs, and therefore, indicates there is no plume to be evaluated in the area. At the time of the RI groundwater investigation, the concentrations in MMW022 were approximately 0.020 mg/L selenium, below the selenium MCL of 0.050 mg/L. This initially warranted addition investigation, because it indicated a completed flow path (but again not above the selenium or other COC MCLs).

Additional investigation included two activities: 1) installation of a new monitoring well (MMW028) to the northwest along the Dinwoody bedding strike. This location evaluates the most critical pathway because Dinwoody groundwater is moving towards the LBFR, and 2) a survey for springs/seeps in the area to the northeast of MMW022, toward the Henry Thrust Fault. Installation of a monitoring well northeast of MMW022 was not considered necessary because this pathway:

- *Is not as critical for any human/ecological receptors,*
- *Was being investigated indirectly by surveying for seeps/springs,*
- *And any possible locations for a monitoring well along this pathway likely would be on other private property, and construction of an access road would be necessary and difficult in any of the suitable locations to the northeast.*

Groundwater results from samples collected from MMW028 (ranging from 0.00264 – 0.0115 mg/L selenium) indicate that the flow path toward the LBFR is complete, but none of the COCs are detected at levels exceeding groundwater standards (MCLs) along this migration pathway. The spring/seep investigation on the hillside to the northeast of MMW022 indicated no spring discharges. Given the geologic (bedding) configuration of the area, if groundwater flow is northeastward, springs could be expected. The absence of springs suggests the predominant flow direction is not northeastward and toward the Henry Thrust Fault. Since the time of these additional investigations, long term monitoring results of MMW022 indicate that the selenium concentrations have increased, but they do not exceed the selenium MCL. Please refer to SC-49 for additional information on the history of investigation activities related to groundwater contained in the Dinwoody Formation.

The field investigations discussed above (i.e., at and around MMW022) and LTM data have shown us that compared to most areas at the Henry Mine, the area around MMW022 has the potential for producing concentrations that exceed the selenium MCL. The reasons for this are that the physical configuration of the reclaimed area is conducive for higher infiltration through a relatively thin layer of waste rock (thinner waste rock deposits appear to leach more selenium due primarily to less attenuation within the waste rock deposit [Hay, *et. al., 2016]). These physical factors will need to be considered when evaluating alternatives for remediation the Site's upland soils/waste rock during the FS.*

A/T Comment: Response OK

b) *Regarding the movement of groundwater in the Dinwoody Formation, please refer to comment response SC-8. The issue related to groundwater movement (hydrogeology) in the Dinwoody Formation are similar to the Wells Formation in that groundwater movement tends to be structurally and lithologically controlled in these two formations at the Site. The most probable flow path in the Dinwoody Formation is toward the LBFR (a low point) along the strike of bedding. However, it is acknowledged that flow to the northeast across structure toward the Henry Thrust Fault cannot be ruled out, and therefore may be a possibility. Because there is no plume exceeding screening levels in the area, the uncertainty should be acceptable. However, the LTM groundwater results do point to the need for a reduction of precipitation infiltration into the closed basin created by the waste rock in the MMW022 area. Future source controls selected during the FS in this location might include increasing the thickness of the ET cover or regrading and diverting stormwater away from the area, etc., which would reduce the potential for further contamination of the underlying Dinwoody Formation groundwater.*

Given the discussions above, there is more certainty than indicated in this Henry RI Report in regard to the northwest flow direction. Therefore, the second sentence of the introductory paragraph of Section 4.5.2.2 has been revised to say:

> *"This location is in the recharge zone for the Dinwoody Formation; constituents from the Site are migrating parallel along the axis of the syncline toward the northwest and the Little Blackfoot River. However, some migration to the northeast toward the Henry Thrust Fault, perpendicular to the syncline axis also is possible (refer to Section 2.6 for further hydrogeology discussion)."*

As discussed above, the basis for this statement is the CSM and the results from MMW028 that indicate some COC migration to that location.

A/T Comment: Response OK

41. Section 4.5.2.2; Page 4-45; Dinwoody Formation

Regarding the elevated selenium concentrations in MMW022 after the "large recharge event of 2011" and that the elevated concentrations are an advancing pulse from an "uncommon" recharge event, as opposed to an advancing plume - following text states that concentrations should decrease in future sampling rounds "*assuming additional anomalous recharge events do not occur."* It cannot be predicted if, and when, another uncommon or anomalous recharge event will occur. This reasoning appears flawed; please revise.

***P4 Response (SC-41)**: Agreed. There will be future high recharge events, and the discussion does not reflect the issue correctly. The issue is not whether a high recharge event will occur in the future (they will), but if there are consecutive events, which might not allow the pulse from an individual event to dissipate. The sentence has been revised to say, "Therefore, the elevated concentrations appear to be related to the uncommon recharge event (an advancing pulse) as opposed to an advancing plume. If the former is the case, then concentrations should decrease in future sampling rounds as the pulse migrates and dissipates and/or attenuates as it moves downgradient (i.e., assuming consecutive or closely spaced anomalously high recharge events do not occur)."*

A/T Comment: Response OK

42. Section 4.5.2.3; Page 4-46; Wells Formation

Text states "flow direction in the Wells Formation at the site is *predicted* to be to the northwest toward the springs…" See previous comment (#35) – the flow direction in the Wells Formation aquifer is important for determination of the fate and transport of COCs. Typically, flow direction in the area is more to west; flow direction should be confirmed by site data. Please clarify and resolve.

P4 Response (SC-42)*: Please see the response to SC-8.*

A/T Comment: Response OK

43. Section 4.5.2.3; Page 4-48; Paragraph 1; Sentence 2

If all but one selenium concentration was a non-detect, then all but one concentration represented in Figures 4-19 and 4-20 should be open symbols. Revise accordingly.

P4 Response (SC-43)*: The sentence is incorrect. The concentrations on Figures 4-19 and 4-20 are correct, and the sentence has been revised as follows: "With one exception (i.e., concentration of 0.017 mg/L in MMW023), selenium concentrations in both monitoring wells are below 0.004 mg/L."*

A/T Comment: Response OK

44. Section 4.5.2.4; Page 4-49; Other Hydrostratigraphic Units

Text describes how the wells are likely downgradient of the mine pit and upgradient of the Lone Pine creek. Provide more data to substantiate this assertion. Show this on the cross section to illustrate the argument.

P4 Response (SC-44)*: Well MPW022 has been projected into Drawing 5-3 showing the relationship between this well and the Lone Pine Creek alluvial system. Conditions at MPW023 are similar, but with slightly flatter gradients. A reference to Drawing 5-3 has been added to the text.*

A/T Comment: Response OK

45. Section 4.5.3; Page 4-51; Water Quality Typing

Text states "were [sic] oxidizing sulfides are a source of selenium." (a) Change "were" to "where" and (b) Are the oxidizing sulfides the actual source of selenium, or do they merely increase the mobility? This statement is not clear – the middle waste shale is typically identified as the source of selenium. Please clarify the statement.

P4 Response (SC-45)*: a) The typo was corrected. b) The sentence in question read, "This is consistent with the conceptual geochemical model, discussed in detail in the RI/FS Work Plan, were oxidizing sulfides are a source of selenium". To address the comment, the sentence has been revised to say, "This is consistent with the conceptual geochemical model, discussed in detail in the RI/FS Work Plan, where oxidizing sulfides in the waste shales are a source of selenium". (The center waste shale [CWS] is a major source of selenium, but other beds in the Meade Peak Member may also contribute.)*

However, please note that in context, the statement questioned is explaining the relationship between sulfate and selenium. The geochemical reservoirs of selenium include, readily soluble selenium compounds, sulfides, and some organically bound selenium. In the Idaho phosphate mines, the soluble selenium compounds typically are identified as the dominant source of selenium to the environment. However, most of this soluble selenium is chemically associated with sulfide weathering (oxidation) that occurred in situ prior to mining. It has been shown that sulfides are the main reservoir of selenium in unweathered CWS (Perkins and Foster, 2004). The sulfides also are the *source of sulfate upon oxidation. Weathering has occurred over geologic time to produce the soluble selenium and sulfate minerals that may be dissolved and be released upon mining. Some amount of oxidation also may occur post-mining depending on specific conditions. Regardless of when the oxidation occurred, because of the chemical relationship, the selenium-sulfate correlation has remained.*

In regard to the portion of the comment related to increased mobility, because of the inherent net neutralization potential of the Phosphoria Formation rocks, pervasive acidic conditions do not develop. Therefore, sulfide oxidation can lead to release of selenium bound in sulfides more so than acid leaching of other minerals and organics that contain selenium.

A/T Comment: Response OK

46. Section 4.5.5; Page 4-53; Aquifer Solids

Text states, "*It is possible* that at this location the alluvium was derived largely from the Meade Peak Member outcrop." Please review drilling logs to evaluate whether information is available to address this question of interest. It should be obvious if the alluvium is derived from the Meade Peak formation. For future characterization activities, the onsite geologist should carefully log the borings and evaluate the provenance of the alluvium to accurately characterize the site. During future investigations, please provide detailed logging and observations of drill cuttings and lithologic samples.

***P4 Response (SC-46)**: It is incorrect to assume that, "it should be obvious if the alluvium is derived from the Meade Peak Formation". The alluvium is dominated by brown clays, silt and sand with some gravel (RI/FS Work Plan, see direct push and well logs). Based on the lithological composition of the geologic units at the Site, the clay and silt largely originates from the Phosphoria, including the Meade Peak Member, or Dinwoody Formations, and much of the sand is likely from the Wells Formation. However, the Meade Peak Member clay does not retain its dark color upon weathering and is not likely visually distinguishable from clays derived from the Dinwoody Formation or Cherty Shale Member (Phosphoria Formation) as an example. No study has been conducted to confirm this, but it is based on field observations including during drilling. Weathered Meade Peak Member rock locally is called brown shale, and it is the source of the Henry Mine cover material. The best way to distinguish the origin of these different clay types is geochemically, because visual confirmation is not possible. Identification of larger rock fragments in the colluvial soils could help identify the source of the material, but the origin of the clays and large rock fragments may be from separate sources.*

All borings were logged by an on-site geologist/hydrogeologist, and the logs are provided in the RI/FS Work Plan or in subsequent RI Data Summary Reports (DSRs). Because the logs have been submitted to the A/Ts, we are not resubmitting these data at this time. However, the RI/FS WP and other DSRs should be available to this reviewer, and if not, can be provided electronically.

A/T Comment: Response OK

47. Section 5.1.4; Page 5-7; Groundwater Pathways

Text states "This resulted in validation of potential pathways and identification of those pathways requiring further investigating." Has further investigation been conducted, and if so, what are the results?

***P4 Response (SC-47)**: The sentence in question is contained in a paragraph describing the overall approach to the groundwater investigation. Further investigation was conducted as part of the RI process, and these data are reported in this Henry RI Report. For example, there were two rounds of* *direct-push investigation. The second round was conducted to address data gaps identified following the conclusion of the first round. Monitoring well MMW028 was installed in response to the results from MMW022. The sentence has been modified to say, "This resulted in validation of potential pathways and identification of those pathways requiring further investigation during the RI."*

A/T Comment: Response OK

48. Section 5.1.4; Page 5-7; Groundwater Pathways

Text states, "Deeper groundwater flows generally along bedrock bedding is either to the northwest or southeast." This statement is confusing as written and suggests a lack of site knowledge. Revise.

***P4 Response (SC-48)**: The sentence highlighted is contained in an introductory paragraph and is followed by "The details of the groundwater contaminant transport pathways for each of the flow systems are presented in the following subsections." Therefore, the uncertainty is addressed in the following sections. However, the conclusion is that evidence indicates that bedrock groundwater flow is dominantly to the northwest, and the sentence has been revised as follows: "Deeper groundwater flows generally along bedrock bedding, primarily to the northwest toward the Henry Springs discharge area."*

A/T Comment: Response OK

49. Section 5.1.4.2; Page 5-9; Dinwoody Formation

This section describes flowpaths from waste dumps into the Dinwoody and general groundwater flow in the Dinwoody Formation. Text states "Contaminated external waste rock dump seepage entering the Dinwoody Formation…..forms complete flow paths." In nearby sites, elevated COCs in the Dinwoody Formation are observed where waste rock dumps directly overlie this unit (for example, elevated COCs are found where MWD086 overlies the Dinwoody and MMW022). Another example where this could occur at the Henry Mine is where MMW085 overlies the Dinwoody Formation (Drawings 2-2 and 5-2 [Section P-P']. No monitoring well is installed to monitor this portion of the Dinwoody Formation (Trd) and is considered a data gap**.** See General Comment B for direction.

***P4 Response (SC-49)**: As presented in the RI/FS Work Plan, the approach was not to investigate every location of possible COC impacts over the large area represented by the Site. The RI objective was to investigate various locations with specific conceptual flowpath configurations that appeared to have the highest probabilities of COC impacts to Site groundwater. In the case of the Dinwoody Formation, the MMW022 location was investigated, and based on field observations and groundwater results from that installation, MMW028 was installed. The MWD085 and MWD086 locations were not considered a large concern as drainage and slopes were more favorable for reducing infiltration.*

The MMW022 location was selected because there is a large area of waste rock overlying the Dinwoody Formation in this area, and the reclamation grading forms a localized closed basin (i.e., surface water must infiltrate because there is no outlet for runoff). Additionally this location is on the possible flow path along the Dinwoody Formation strike, which is towards the LBFR. MMW028 was installed further to the northwest (again along strike) the next year, after elevated concentrations of selenium were detected in MMW022, to address the most critical possible flow path along strike towards the LBFR (refer to Drawing 2-2 for the locations of these wells).

Based on the conceptual Site model and flow path associated with MMW022, no further investigation of the "waste rock – Dinwoody on-lap" was conducted. This was largely because the MMW022 location represents a "worst case" position along the flowpath, but has not exceeded COC screening levels (the sulfate screening level has been exceeded, but it is not a COC).

One point of further clarification needs to be made. These Dinwoody monitoring wells (i.e., MMW022 and 028) were installed and sampled prior to development of the RI/FS Work Plan. The groundwater results from these wells were considered in scoping the RI/FS Work Plan and the A/T concurred with the Dinwoody Formation investigation approach that included no additional Dinwoody Formation monitoring wells (i.e., it was determined that there was not a data gap).

A/T Comment: Response OK

50. Section 5.1.4.3, Page 5-9; Wells Formation Groundwater System

As noted, the Wells Formation is considered a host of regional and/or intermediate groundwater systems. The report provides a compelling argument that the Wells Formation groundwater is fault-controlled and that, "these Faults appear affecting and focusing regionals groundwater transport and discharge" and that "This flow direction is supported by site data, specifically the piezometric levels in monitoring wells MMW011 and MMW023."

a. The wells Formation is interrupted by folding and faulting throughout the region. However, regional data indicate that despite the structural controls, the Wells Formation aquifer exhibits a relatively uniform groundwater elevation and gradient, with flow generally to the west. Two monitoring wells located in the northern part of the site do not necessarily provide the required data to evaluate site-wide flow directions and gradients. This is a potential data gap. Please include regional data from other mine sites (e.g. data from 2010 Technical Memorandum – Groundwater Flow in the Wells Formation), or other wells constructed in the Wells Formation to enhance the discussion and support assertions (in addition to the two observed piezometric levels on site). See General Comment B for direction.

b. No monitoring wells have been constructed south of the LBFR so, despite open and backfilled mine pits and large areas of Wells Formation outcrop, the entire southern two-thirds of the site has no groundwater data for Wells Formation. For example, Drawing 5-3 (Cross Section N-N') shows an idealized scenario where a backfilled/open mine pit with a pond (MSP055, which contains elevated cadmium, nickel, selenium, and zinc that exceed surface water and groundwater screening levels) could recharge directly into the Wells Formation and introduce COCs. This is considered a data gap. See previous comment, and also General Comment B for direction.

***P4 Response (SC-50)**:*

a) Please see the response to Comment 8 (SC-8). Data from mines miles away do not provide any insight into groundwater flow at the Site.

b) Several discussion points should be considered in response to this question. First, pond MSP055 is a seasonal pond located on the mine pit floor, which primarily overlies the Meade Peak Member (CWS, etc.). However, it does abut the Wells Formation-Meade Peak Member contact. Second, the water table was quite high in this area of the mine as indicated by P4's installation of dewatering wells MPW022 and MPW023. The elevated water table in this area further supports the northwest flow component at the Site, making MMW011 downgradient. Third, the flow path is contained within the Site and is monitored by two downgradient monitoring wells – MMW011 and MW023.

P4 does not agree that there is a data gap as Wells Formation groundwater flow in this area is restricted to the northwest and into the core of the Site as discussed in Response SC-8. Because of surface water risks, MSP055 will be addressed in the FS. Remedial action (RA) solutions for this location should be relatively straightforward (e.g., lined surface water collection and retention systems; backfill, grading and applied cover system over portions of the pond area; and/or run *on/run off controls), and the RA construction work can address both the surface water and possible groundwater issues based on the FS evaluations.*

A/T Comment: Response OK

51. Section 5.1.4.4; Page 5-11; Structural Flow System

The second paragraph describes a potential east-west trending structure located between MMP-041 and MMP043, and the third paragraph describe other smaller faults in the site vicinity. The report concludes that these potential structures would not likely affect groundwater flow. The reviewer would like to acknowledge that he appreciates the extra effort put into the site investigation to look further than existing data points to identify previously unknown structures and evaluate their potential to influence COC fate and transport. Nice job.

***P4 Response (SC-51)**: Thank you. As noted in SC-8, groundwater flow in the Wells Formation is strongly influenced by the location and orientation of the Wells Formation (i.e., the local geology including the structural geology component), in particular, the sandstone beds in the upper portion of the unit. Any disruption in the continuity of the unit would be significant for the CSM, and therefore, had to be evaluated.*

A/T Comment: Response OK

52. Section 5.3.3; Page 5-18; Surface Water

The text states that COCs do not make it to LBFR via Lone Pine Creek and that the most downstream affected station is MST057. Suggest adding that MST056 is non-detect and therefore delineates the downstream extent of COCs in Lone Pine Creek.

***P4 Response (SC-52)**: Agreed. The text has been revised to state that concentrations of all COC/COECs are below surface water screening criteria at MST056, which therefore delineates the downstream extent of elevated COCs/COECs in Lone Pine Creek.*

A/T Comment: Response OK

53. Section 5.3.3, Page 5-18, Paragraph 2, Sentence 3

Dilution is one of several processes through which attenuation may occur. Revise the sentence to read "Through attenuation (e.g, dilution)…"

The second part of this sentence "…concentrations of contaminants…" should be revised to read "…<u>elevated</u> concentrations of contaminants…"

***P4 Response (SC-53)**: Agreed. The first part of the sentence has been revised to read "…. through attenuation (e.g., dilution, sorption, or redox reactions)". The second part has been revised as suggested.*

A/T Comment: Response OK

54. Section 5.3.4; Page 5-20; Groundwater

The text states "The southeast portion of waste rock dump MWD085 is adjacent to and overlies the basalt (Drawing 2-2). Therefore seepage or infiltration from MWD085 may recharge and could cause impacts to groundwater within the basalt." Based on Drawings 2-2 and 5-2 (Cross Section P-P'), MWD085 overlies the Dinwoody and upper Meade Peak (Rex Chert/Cherty Shale) formations, but does not directly overlie basalt. Please revisit and revise this discussion to be more accurate. In addition, no data are available to evaluate the potential impacts to the Dinwoody Formation beneath MWD085; and is thus considered a data gap. See General Comment B for direction.

***P4 Response (SC-54)**: The comment is correct; the waste rock is not mapped as directly overlaying the basalt. However, a flow path still exists via the alluvium that tends to pinch out on the basalt. The sentence in question has been revised to say, "The southeast portion of waste rock dump MWD085 is adjacent to the basalt (Drawing 2-2). Therefore, seepage or infiltration from MWD085 into the alluvium could flow downhill, infiltrate the basalt and could cause impacts to groundwater within the basalt."*

Based on the Dinwoody investigation adjacent to MWD086 and MWD088 (MMW022 and MMW028), it was determined that investigation of Dinwoody Formation below MWD085 was not necessary. P4 does not consider this a data gap. See response SC-49 for additional discussion.

A/T Comment: Response OK

55. Section 5.3.4.1, Page 5-23; Alluvial System

Text states "Groundwater samples collected further downgradient at BH169 (0.016 mg/L)…" Double-check this value; it should be 0.0016 mg/L.

***P4 Response (SC-55)**: This value has been corrected in the revised Henry RI Report text (as provided in your comment – 0.0016 mg/L).*

A/T Comment: Response OK

56. Section 5.3.4.2; Page 5-24; Dinwoody Formation

The text describes:

- the interaction between waste rock dumps and the Dinwoody Formation, where the lack of alluvial material allows direct infiltration into the Trd;
- how MMW022 was installed as a "worst case" scenario to evaluate COC loading in the Trd; and
- how MMW022 shows elevated COCs (near the MCL for selenium) that are related to the large recharge of 2011.

This discussion reinforces the need for a monitoring well in the Dinwoody underneath MWD085, which is in direct contact with the Dinwoody (outcrops of Dinwoody are clearly evident adjacent to this waste rock pile). This appears to be an idealized situation to contribute elevated COCs into the Dinwoody and reduce its potential as a beneficial use aquifer. See also Specific Comment 55.

***P4 Response (SC-56)**: Please see responses to SC-49 and SC-54.*

A/T Comment: Response OK

57. Section 5.3.4.3; Page 5-26; Wells Formation

The text attributes low concentrations of COCs in the Wells Formation to a lack of selenium mobility in reducing conditions and reducing flowpaths, among other reasons. However, no monitoring well is constructed in the Wells Formation beneath pond MSP055, which contains some of the highest COC concentrations at the site and sits directly on Wells Formation exposed in the mine's footwall. Clarify how this determination was made.

***P4 Response (SC-57)**: See response to SC-50.*

A/T Comment: Response OK

58. Section 5.3.4.4; Page 5-26; Migration Summary in Site Groundwater Systems

The text states, with respect to the Dinwoody Formation, that "concentrations in the unit increase with increased winter precipitation and snowmelt. However, to date screening criteria have not been exceeded in this unit." Note that in MMW022, the average sulfate concentration exceeds the screening level, and selenium is very close to the MCL. It is possible that future large precipitation events could push the selenium level higher. Revisit and revise narrative.

***P4 Response (SC-58)**: The text has been revised to be consistent with response SC-41. The bullet now reads, "The conceptual model of contaminant transport into the Dinwoody Formation groundwater on the northeastern edge of the Site appears to be validated, and concentrations in the unit increase with increased winter precipitation and snowmelt. However, to date screening criteria have not been exceeded in the unit with the exception of sulfate, which is not a COC based on its screening criteria (i.e., secondary MCL) not being an ARAR. It is possible that future selenium concentrations could exceed screening levels as the result of sequential or closely spaced above average precipitation years."*

A/T Comment: Response OK

59. Section 6.1, Page 6-3, Paragraph 2, Sentence 3

Remove the two occurrences of "incremental" from the sentence. Using "incremental ILCR" is duplicative since ILCR is an acronym for incremental lifetime cancer risk.

***P4 Response (SC-59)**: Please note that the "I" for incremental in "ILCR" indicates that the cancer risk presented is the increase in cancer risk above the incidence of cancer in the general population (about one in three). In contrast, the "incremental" in "incremental ILCR," as defined in the first sentence of the referenced paragraph, refers to the increase in cancer risk associated with historic activities at the Site above the cancer risk associated with constituents present at regional background or ambient concentrations.*

The first two sentences of the referenced paragraph state: "The Tier II HHRA also includes the calculation of RME-based incremental risk estimates, defined as the COPC-specific difference between the risk estimates for Site and background sample locations. COPC-specific incremental ILCR and HQ estimates are summed to cumulative incremental ILCRs and HIs for each medium and receptor." As described above, the first sentence defines incremental ILCR estimates and the incremental HQ estimates presented in the BRA for the Henry Site as the ILCR/HQ estimates calculated from concentrations of COPCs measured in media at Henry Site sample locations minus the ILCR/HQ estimates calculated from concentrations of COPCs measured in media at background sample locations. To clarify this point, the first two sentences of the referenced paragraph have been revised as follows: "The Tier II HHRA also includes the calculation of RME-based incremental ~~risk~~ ILCR and HQ estimates, defined as the COPC-specific difference between the ~~risk~~ ILCR and HQ estimates for the Site and the ILCR and HQ estimates for background sample locations. COPC-specific incremental ILCR and incremental HQ estimates are summed to cumulative incremental ILCRs and incremental HIs for each medium and receptor." Additionally, the final sentence of the third paragraph of 6.1, on page 6-2, has been revised as follows: "For each receptor evaluated, incremental lifetime cancer risks (ILCRs), defined as the incremental increase in cancer risk above the incidence of cancer in the general population, and noncancer hazard quotients (HQs), defined as the ratio of exposure to a noncarcinogenic constituent and the exposure level for that constituent at which no adverse effects are expected, are calculated for individual chemicals.~~; and~~ Subsequently, cumulative ILCR and cumulative HQs, or hazard indices (HIs), are calculated for all chemicals over all applicable exposure media.

Section 3.3.4 of Appendix A has also been revised to clarify the definitions of ILCR, HQ, incremental ILCR, and incremental HI.

A/T Comment: Response OK

60. Section 6.4, Page 6-6, bullets.

Revised the introductory sentence for the bullets to say, "… are generally interpreted as follows:" Also, the second and third bullets are confusing as written. The second bullet indicates that exposures above the no observed adverse effect level (NOAEL), but below the lowest observed adverse effect level (LOAEL), may pose an unacceptable risk to individuals; the third bullet indicates exposures above the LOAEL may pose an unacceptable risk without clarifying whether this is for individuals, populations, or both. Add clarifying language to these bullets.

***P4 Response (SC-60)**: "Generally" has been added to the introductory sentence for these bullets, and the third bullet has been revised to indicate that a LOAEL-based HQ greater than 1 indicates that adverse effects may occur to populations of ecological receptors in Section 6.4 the RI, and in Sections 4.2.4 and 5.2.4 of Appendix A. Additionally, "may occur to individual receptors" has been added to the second bullet in Sections 4.2.4 and 5.2.4 of Appendix A.*

A/T Comment: Response OK

61. Section 6.6.2; Page 6-12; Paragraph 5; Sentence 2

Stick to talking about the long-tailed vole and save discussion on the deer mouse for its own section. Revise accordingly.

***P4 Response (SC-61)**: The deer mouse was referenced in the text for the long-tailed vole in order to support elimination of antimony from further evaluation as a risk driver in upland soil/waste rock. However, conclusions regarding risk drivers for individual media are more appropriately described in Section 6.9.4. Therefore, the discussion of ecological hazard associated with antimony in upland soil/waste rock has been moved to Section 6.9.4. Similarly, as indicated in the response to SC-98, the comparison of Henry Site and background hazard estimates for the mink has been moved to the risk summary in Section 6.9.4.*

In Appendix A, the Tier II ecological hazard estimates presented in Section 4.3.2 include the same evaluations of hazard estimates associated with Site media relative to hazard estimates for background media under receptor-specific headings. These discussions have been moved to a new Section 4.3.3.

A/T Comment: Response OK

62. Section 6.6.2; Page 6-13; Paragraph 4; Sentence 2

Stick to talking about the deer mouse and save discussion on the long-tailed vole for its own section. Revise accordingly.

***P4 Response (SC-62)**: Please refer to the response to SC-61.*

A/T Comment: Response OK

Tables

63. Include a table that provides a summary of COC concentrations in monitoring wells.

***P4 Response (SC-63)**: A new table has been referenced in Section 4.5, which provides a summary of COC concentrations in the monitoring wells.*

A/T Comment: Response OK

64. **Table 4-5.** The highlighting for the seventh note listed should be removed.

    P4 Response (SC-64)*: This change has been made in the revised report.*

    A/T Comment: Response OK

65. **Table 4-11.** Describe whether these metals concentrations are for total or filtered analytical results. Considering these are for comparisons with MCLs or state groundwater standards, the appropriate comparison should be with total metals concentrations.

    P4 Response (SC-65)*: The metals concentrations in Table 4-11 are for total analytical results. A note has been added to Table 4-11 indicating that concentrations in the table are for unfiltered (total) groundwater metals results.*

    A/T Comment: Response OK

66. **Table 4-14.** There are a number of values listed as 0.000 or 0.0. Revise the table to show the correct significant figures.

    P4 Response (SC-66)*: The table has been revised to show the correct significant figures.*

    A/T Comment: Response OK

67. **Table 4-16.** A note should be added that describes what the highlighted values in the table mean.

    P4 Response (SC-67)*: A note has been added that states "highlighted values indicate stations where fish were observed."*

    A/T Comment: Response OK

68. **Table 6-16.** EPA released new federal water quality criteria for selenium in June 2016 that no longer supports the previous 0.005 mg/L chronic criterion. The current federal WQC document recommends water-based lentic and lotic values of 1.5 and 3.1 µg/L, respectively, along with tissue-based. Revisions to the table are necessary to acknowledge the updated federal criteria for selenium.

    P4 Response (SC-68)*: See response to GC-D.*

    A/T Comment: Response OK

69. **Table 6-16.** This table indicates that site-wide surface water exposure point concentrations (EPC) were used to evaluate risk to aquatic organisms. This may be appropriate for some upper trophic level receptor's exposure; however, amphibians, fish, and invertebrates will be exposed within a singular waterbody. The risk screening needs to be revised to be representative of the exposures to which aquatic organisms within specific waterways will be exposed.

    P4 Response (SC-69)*: Agreed. Although some ephemeral surface water stations are likely too small to support aquatic life, Site-wide EPCs in Table 6-16 (and in Table A4-21) have been replaced by the Site-wide maximum detected concentration to identify risk drivers. A waterbody-specific evaluation was not done in Section 6.0; such an evaluation would be redundant with Section 4.4 and Drawings 4-9 and 4-10 in this RI, which compare waterbody-specific concentrations to screening criteria.*

    A/T Comment: Response OK

Drawings

70. The geologic cross sections illustrate a dearth of groundwater monitoring wells, resulting in suspected/inferred groundwater elevations and flow directions. For example, sections B-B' and P-P' only have one monitoring well, and the others only show two monitoring wells. If possible, add more data to the cross sections, such as projecting other wells and sample results to form a more complete picture of the CSM and COC Fate and Transport.

P4 Response (SC-70): *Because of the size of the Site, the data points are spaced at considerable distances from each other. It is possible to bring these points together in the direction of a cross section, but bringing them in from the lateral distances involved does not provide a representative (or clearer) picture. Surficial geology including contacts, strike and dip of bedding, and structures has to be utilized. This is why the sections are indicated as "schematic" and are used to convey concepts. We have added MPW022 to Drawing 5-3.*

A/T Comment: Response OK

71. Drawing 2-2

Change the symbol for MMW019 to represent a local aquifer monitoring well.

Change the symbol for MMW004 to represent a local aquifer monitoring well.

P4 Response (SC-71): *MMW019 symbol has been revised to a local aquifer monitoring well. As shown on Table 3-5, the screened interval is unknown for MMW004. It can be assumed based on the location and depth of this well that is screened in the local aquifer, but this cannot be confirmed. For this reason, the symbol for MMW004 has not been revised.*

A/T Comment: Response OK

72. Drawing 2-3

Show the groundwater elevation in the Wells Formation.

The schematic groundwater flow vector in the Wells Formation' indicates downward flow, but text describes flow to the north. Is there a downward component of flow? If so, provide data to support this assertion. Similar comment for the Dinwoody Formation flow vectors – text (and Figure 5-3) describes possible flow to north along the axis of syncline, not eastward

The selenium concentration of 0.017 mg/L in MMW022 is from 2008. Yet the selenium concentration was approximately 0.045 mg/L in 2014. It is unclear why this drawing presents an older, lower concentration of selenium. Either provide justification for this, or update with the more recent concentration.

P4 Response (SC-72): *Because the dominant flow directions in both the Dinwoody and Wells Formations are perpendicular to the section, the flow arrows are confusing. The drawing has been revised to help clarify the relevant flow patterns. Please note that the downward flow arrow on the Wells Formation indicates flow along bedding to the groundwater table where flow is then to the northwest. Addition of an inferred potentiometric surface will help depict that flow path.*

The purpose of presenting the concentrations was to illustrate a uniform picture of the Site at one time as possible, not to present maximum concentration regardless of when they occurred. Data from 2008 was selected based on when the drawings were originally developed and the completeness of the data set. A note has been added to the drawings to indicate sampling dates and reference Appendix B for a complete table of historical results.

A/T Comment: Response OK – However, for the record, it might be considered misleading to present older, lower COC concentrations when more recent monitoring indicated higher concentrations.

P4 Supplemental Response: *The cross-sections depicted in Drawing 2-3 and Drawings 5-2 to 5-4 have been updated with 2014 data, where available, and are indicated as such in the notes.*

73. Drawing 3-3

Change the symbols for agricultural wells MAW004, 006 and 007 to represent agricultural wells.

Change the symbols for domestic well MDW0001 to represent a domestic well.

P4 Response (SC-73)*: The symbols on Drawing 3-3 for monitoring wells as well as agricultural and domestic wells indicate the screened geologic unit based on drilling logs. For example, MDW001 is screened in the local aquifer, and MAW006 is screened in the Dinwoody Formation. A general symbol is used for wells when the screen interval is unknown or if the well is screened over multiple aquifer. An acronym list of well descriptors (e.g., MAW – agricultural well) has been added to Drawings 3-3 and 4-11.*

A/T Comment: Response OK

74. Drawing 4-11

Show interpreted flow directions for alluvial and bedrock groundwater flow systems.

For direct-push boreholes (BH) that exceed the selenium MCL, highlight or bold to demonstrate exceedances; alternately, shade the general impacted area.

Expand this drawing to the northwest to show the location of Henry Springs, and include sample results for Henry Springs (as this spring is described as a discharge for the Wells Formation).

Show other sample results (for example, results of MAW004, 006, and 007). These agricultural wells would appear to be important potential receptors.

MDW001 is shown, but no sample results are shown; according to Table 3-4, this well is not part of the sampling protocol. Add wells MDW003, MAW003, and MDW005 and include any sampling results.

P4 Response (SC-74)*: The suggested changes have been made with the exception of showing data for the Henry Springs (see response to SC-8).*

A/T Comment: Response OK

75. Drawing 5-2

Based on this cross section, the Dinwoody Formation below MWD085 would be a very good placement for a monitoring well to evaluate COC migration from the waste rock into this aquifer.

Show the groundwater flow direction in the Wells Formation.

P4 Response (SC-75)*: Regarding the Dinwoody, please see responses SC-49 and SC-54. A note has been added to the drawing indicating that groundwater flow in the Wells Formation is into the drawing to the northwest.*

A/T Comment: Response OK

76. Drawing 5-3

Show the groundwater elevation and flow directions in the Wells Formation.

Add MPW022 and sample results.

Add MSP055 and sample results.

> ***P4 Response (SC-76)**: The suggested edits/additions have been incorporated into Drawing 5-3.*
>
> **A/T Comment:** Response OK

77. Drawing 5-3

Label the sliver of waste rock (?) overlying the Dinwoody Formation and Qw between Stations approximately between 1300 and 2000.

Note that having an additional Dinwoody Formation monitoring well north/northwest of this section, under MWD085, would allow for extending this cross section to the north to illustrate a larger picture of groundwater elevations and apparent gradient in the Dinwoody Formation, and provide a more complete CSM. As noted previously, lack of a Dinwoody Formation monitoring well under MWD085 is considered a data gap that should be addressed; see General Comment B for direction.

> ***P4 Response (SC-77)**: The sliver of waste rock pile MWD088 on Drawing 5-4, Section V-V', has been labeled. Drawing 5-3 is Section N-N', which does not cross MWD088. See responses SC-54 for discussion of the Dinwoody Formation and waste rock dump MWD085.*
>
> **A/T Comment:** Response OK (A/T comment mistakenly referenced Drawing 5-3, but meant 5-4)

78. Drawing 5-4

Reference somewhere that Drawing 2-2 shows the location of Cross Section V-V'.

> ***P4 Response (SC-78)**: Notes have been added to Drawings 5-2, 5-3, and 5-4 indicating that all the cross sections drawn for the Henry Site are indexed on the Drawing 2-2 (which also provides the site geology).*
>
> **A/T Comment:** Response OK

Appendix A – Risk Assessment

79. Appendix A; Page 2-2

Suggest additional bullet to BRA representativeness list:

- Human representativeness: Are surface soils and sediments sized to represent particles likely to adhere to skin and consequently ingested? If not, discuss as an uncertainty.

https://semspub.epa.gov/work/HQ/100000133.pdf

> ***P4 Response (SC-79)**: The referenced document is applicable to evaluation of lead-contaminated sites where lead shot may be present, and is not applicable to the P4 Sites based on site history and the nature of the contamination that is present. Therefore, we do not believe that a discussion of particle size is appropriate for the representativeness bullets on Page 2-2. However, the final bullet of Section 6.1 of Appendix A has been revised to include a discussion of soil particle size as related to oral exposures.*
>
> **A/T Comment:** Although the document was prepared by the EPA Technical Workgroup for Lead, the supporting studies are based on particle size as a controlling variable for dermal adherence and subsequent percutaneous absorption and ingestion. The results are fully applicable to assessing human exposure to all particulate contaminants in soil (Ruby and Lowney 2012, Stalcup 2016).

P4 Supplemental Response: *Because soil particle size data was not collected during the Henry Mine Site remedial investigation (RI), consistent with the Ballard, Henry and Enoch Valley Mines, Remedial Investigation and Feasibility Study Work Plan (MWH, 2011), P4 doesn't believe it's appropriate to discuss this issue in the Data Evaluation and Summary section of the BRA. However, as agreed during the comment resolution call between P4 and the A/Ts on April 24, 2017, a brief discussion of the uncertainties in not having such data on the exposure assessment was included in the Uncertainty Analysis section.*

80. Appendix A; Page 3-1

Update risk estimates using the most recent version of the EPA Superfund Exposure

Factors (2014): https://www.epa.gov/risk/update-standard-default-exposure-factors

P4 Response (SC-80)*: The primary source for exposure factors used in the Ballard Site BRA was IDEQ (2004), as described in the A/T-approved RI/FS Work Plan; these exposure factors have been retained in the Henry Site BRA for consistency between the P4 Sites. The updated USEPA exposure factors are not significantly different from the IDEQ exposure factors used in BRAs for the Ballard and Henry Sites.*

A/T Comment: Response OK

81. Section 3.1; Page 3-2; Paragraph 3; Last sentence

Add to Section 3.1 that EPA Regional Screening Levels (RSLs) (2015a) were also used in the screening process of constituents of potential concern (COPC) in surface and groundwater. Use the most updated citation of the RSLs (May 2016) if indeed values evaluated for the Henry Site are the same as EPA 2015 RSLs.

P4 Response (SC-81)*: Please note that USEPA RSLs currently are listed under surface water as source number 3, and under groundwater as source number 1 on Page 3-3. At the time of selection of COPCs, the most current version of the USEPA RSLs was November 2015. However, prior to submittal of the draft Henry RI Report in August 2016 the November 2015 RSLs were compared with the May 2016 RSLs to ensure that the semi-annual revision did not affect the COPC selection for the Henry Site. Text describing this comparison has been added to Section 3.1.*

A/T Comment: Response OK

82. Section 3.1, Page 3-2, Paragraph 3

The National Recommended WQC listed is out of date. The most recently published version is July 28, 2016. Update reference accordingly in the text and tables throughout the report.

P4 Response (SC-82)*: The reference to the USEPA's NRWQC website has been updated to 2016 as requested.*

A/T Comment: Response OK

83. Section 3.1, Page 3-2, Paragraph 3

The EPA's RSL is out of date. The most recently published version is May 2016. Update reference accordingly in the text and tables throughout the report.

P4 Response (SC-83)*: Please refer to the response to SC-81.*

A/T Comment: Response OK

84. Section 3.3, Page 3-4, last paragraph.

As recommended by EPA's ProUCL software, the upper confidence limit (UCL) (95 percent or other) should be used as the EPC and not default to a maximum detected concentration (MDC) that is lower than that UCL. EPA no longer recommends defaulting to the MDC. The MDC is not recommended for risk assessment purposes because for small (for example, n < 10 to 20) or skewed data sets it does not provide the specified 95 percent coverage to the population mean, and for larger data sets it typically overestimates the EPC. If the MDC is below the UCL, then the question should be asked whether the data set is sufficient for risk assessment purposes and whether a data gap exists. While this situation may be unavoidable for some media (for example, as a result of limited numbers of culturally significant vegetation available to sample), the uncertainties it imposes on the risk estimate need to be fully discussed in the uncertainty section of the report. Looking at the EPC summary tables (Tables A3-8 through A3-14), it appears that the maximum detected value was only selected for culturally significant vegetation (CSV), which is unavoidable due to the limited availability of these plant types. Therefore, revise the text to indicate that the recommended UCL from ProUCL was used for all media except for CSV, which limited samples required defaulting to the maximum detected concentrations.

> ***P4 Response (SC-84)****: Text in Section 3.3 has been revised as follows: "The Tier II HHRA evaluated EPCs based on upper-bound average concentrations ~~of EPCs (i.e., the lower of either the maximum detected concentration or the ProUCL recommended 95%, 97.5%, or 99% upper confidence limit [95% UCL; 97.5% UCL; 99% UCL]) on the mean concentration~~, using both RME and CTE exposure assumptions. Tier II EPCs were equal to the ProUCL recommended 95%, 97.5%, or 99% upper confidence limit (95% UCL, 97.5% UCL, or 99% UCL) on the mean concentration for all analytes and media where there were sufficient number of detected sample results to perform statistical evaluations. For analytes and media with insufficient detected sample results (e.g., several analytes in upland culturally significant vegetation tissue), the EPC was equal to the maximum detected concentration."*
>
> **A/T Comment:** Response OK

85. Section 3.3.1.2; Page 3-6; Paragraph 3

The document states: "A review of the USEPA's Exposure Factors Handbook (USEPA, 2011) indicates that only about 1% of inhabitants in the Western U.S. consume wild game, and less than 1% (i.e., 0.6%) of Native Americans consumes wild game. Furthermore, mean intake rates of wild game by Western U.S. residents and Native Americans are 0.012 grams per kilogram per day (g/kg-d) and 0.001 g/kg-d, respectively. In comparison, mean intake rates for 'total meats' by Western U.S. residents and Native Americans are 1.903 g/kg-d and 2.269 g/kg-d, respectively. As a result, wild game contributes only about 0.63% of the total meat consumed by Western U.S. residents and 0.044% of the meat consumed by Native Americans." The reviewer was not able to locate this information in the 2011 EPA Exposure Factors Handbook; please specify the table, chapter, or the study cited in this document that contains these assertions.

> ***P4 Response (SC-85)****: The percent consuming and per capita consumption rates are presented in Table 11-6 of the 1997 version of the Exposure Factors Handbook (EFH). The 1997 EFH included statistics for consumption of game in Chapter 11, which addresses overall meat consumption, while the 2011 EFH includes statistics for consumption of game in Chapter 13, which only addresses home-produced food. Table 13-41 of the 2011 EFH indicates that approximately 1% of people in the west consume game, consistent with Table 11-6 of the 1997 EFH. Table 13-41 does not have a percent consuming for Native Americans. Because the 2011 EFH does not have statistics for Native*

Americans, 1997 EFH Table 11-6 statistics for percent consuming wild game were retained in text. The text in Section 3.3.1.2 has been modified to remove the per capita meat ingestion rates.

A/T Comment: Response OK

86. Section 3.3.1.2; Page 3-6

If the mean is the average of 1 percent of consumers and the 99 percent who don't consume, then this a misleading statement. Because the purpose of the risk assessment is to assess the risk to exposed people, it is inconsistent to estimate exposure factors by averaging rates of exposed and unexposed people. The risk to people consuming wild game must be based on *their consumption rate,* not the average of consumers and nonconsumers. Based on this text, it appears that game consumption rates were significantly underestimated. The consumption rate should be based on an upper percentile estimate of consumers; not a per capita estimate. The 2011 EPA Exposure Factors Handbook should be referenced to correct this value.

P4 Response (SC-86)*: The purpose of text in Section 3.3.1.2 is to indicate that game consumption rates in the western United States and among Native American populations are low, and therefore there is minor uncertainty associated with evaluating only one game species (i.e., elk). Text comparing per capital game ingestion rates to per capita meat ingestion rates has been removed from Section 3.3.2.1 the revised BRA. Please refer to P4's response to SC-87 for a discussion of the game ingestion rates that are used in the Henry Mine BRA.*

A/T Comment: Response OK

87. Section 3.3.1.2, P3-6, Paragraph 3

The wild game consumption rates provided in this section seem to be quite low for those populations that do consume wild game; these rates could not be located in the referenced document by this reviewer to verify. Provide additional information on where these rates were taken.

P4 Response (SC-87)*: Consumption rates for wild game are consistent with rates used in the approved Ballard Site BRA, and were derived as described in footnote s to Table A3-7:*

> *The ingestion of game rates for a seasonal hunter were time-weighted ingestion rate for ages 16-46 from Table 13-41 of USEPA's Exposure Factors handbook (2011b) and adjusted for 29.7% meat preparation and cooking loss and 29.7% post-cooking loss (Table 13-69 from USEPA 2011b), consistent with the human health risk assessment technical memorandum for the Smoky Canyon Mine Site (Formation Environmental LLC, 2013). The CTE (mean) and RME (99th percentile) adult Native American ingestion of game rates were obtained from Table 11-6 of the 1997 Exposure Factors Handbook (USEPA, 1997b). The child Native American ingestion rates were estimated from the adult ingestion rates assuming a child eats 45% of the meat consumed by an adult (based on values in Table 13-1 of USEPA, 2011b). All grams per kilogram per day adult ingestion rates were converted to grams per kilogram assuming a body weight of 70 kilograms.*

A/T Comment: Meat cooking losses consist of water or fats, this may not be appropriate for selenium, cadmium, and other COPCs which are likely bound to sulfhydryl sites on proteins. Please address.

P4 Supplemental Response: *As agreed to during the comment resolution call between P4 and the A/Ts on April 24, 2017, the adjustment for meat preparation and cooking loss was removed from the game consumption intake rates for the seasonal hunter. The adjustment factor for post-cooking loss (e.g., removal of fat and bones) was not removed.*

The intake rate for the Native American, derived from Table 11-6 of the 1997 Exposure Factors Handbook, was for game "as consumed," and therefore did not include an adjustment for cooking or post-cooking loss. After further consideration of the game consumption rates for the Native American, we agree that the game consumption rate for a Native American (i.e, 0.255 grams per kilogram body weight per day [g/kg-d], or 18 grams per day for an adult) appears low. This consumption rate was replaced with the rate listed under Other/NA in Table 11-6 of the 1997 Exposure Factors Handbook (i.e., 0.363 g/kg-d, or 44.5 grams per day for an adult).

88. Appendix A; Page 3-8

Consider globally replacing "receptors" with "exposed" or "potentially exposed people."

***P4 Response (SC-88)**: Comment Noted. "Receptors" is common risk assessment terminology for the potentially exposed populations being evaluated, as defined in Section 3.3.1.2. Because "receptors" is a simple term with one meaning within the risk assessment, it can be used in a variety of sentence formats without the ambiguity that might occur with a longer phrase such as "potentially exposed people."*

A/T Comment: Response OK

89. Section 3.3.2.1, Page 3-11, last paragraph, last sentence

See previous comment regarding the MDC. EPA's ProUCL software, the UCL (95 percent or other) should be used as the EPC and not default to an MDC that is lower than the UCL. EPA no longer recommends defaulting to the MDC.

***P4 Response (SC-89)**: Please refer to the response to SC-84.*

A/T Comment: Response OK

90. Appendix A; Page 3-12

Use the most recent version of ProUCL Software (v. 5.1) available at:

https://www.epa.gov/land-research/proucl-software

***P4 Response (SC-90)**: The 95% UCL on the mean concentrations for Henry Site datasets were calculated prior to the release of ProUCL v 5.1. However, comparison of a subset of Site EPCs calculated using ProUCL v. 5.1 to EPCs calculated using ProUCL v. 5.0 indicates that risk estimates recalculated based on EPCs derived using ProUCL v. 5.1 differ only slightly (if at all) from current risk estimates. Based on the above, P4 believes that the level of effort required to recalculate EPCs for all COPCs and COPECs in all media based on ProUCL v. 5.1 is not warranted.*

A/T Comment: Response OK

91. Section 3.3.2.2; Page 3-12

Suggest moving all this section as a new attachment (Exposure Estimation Equations for HHRA).

***P4 Response (SC-91)**: Comment noted. Although this section is lengthy, it contains information that reinforces methods described elsewhere in the report, and is most appropriate as a subsection to Section 3.3.2.*

A/T Comment: Response OK

92. Appendix A; Page 3-24

Replace the outdated IRIS Uranium RfD with the ATSDR oral MRL value (see attached correspondence expressing support from EPA Head Quarters): http://www.atsdr.cdc.gov/toxprofiles/tp150.pdf

P4 Response (SC-92)*: Please refer to the response to GC-C.*

A/T Comment: Please update to incorporate revised EPA Guidance recommending use of the ATSDR MRL in place of the MCL or IRIS RfDs

https://semspub.epa.gov/work/HQ/196808.pdf

P4 Supplemental Response: *Agreed. Please see the response to GC-C.*

93. Appendix A; Page 3-27

The EPA preliminary remediation goal calculator can accept user-derived exposure or toxicity values included in the Particle Emission Factor.

P4 Response (SC-93)*: The particulate emission factor (PEF) used in inhalation dose calculations for chemicals in the BRA for the Henry Site was calculated using the PEF equation in Appendix D of the USEPA's Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (USEPA, 2002) and default parameter values in Idaho Department of Environmental Quality's (IDEQ's) Idaho Risk Evaluation Manual (IDEQ, 2004), including a default value for the variable Q/C_{wind}. The EPA calculator, which was used to calculate preliminary remediation goals (PRGs) for radium-226 in the BRA for the Henry Site, does accept user-derived values for the site area (A_s), mean annual windspeed (U_m), equivalent threshold value (U_t) fraction vegetated cover (V), and (by default, given U_m and U_t), f(x). However, The value of Q/C_{wind}, is calculated in the calculator based on the user-input A_s and user-input climatic zone. The value of Q/C_{wind} generated by the calculator for Boise, Idaho is significantly different than the value of Q/C_{wind} in IDEQ (2004), which is approximately equal to the Q/C_{wind} value for a 0.5 acre site in Boise, Idaho from USEPA (2002). It should be noted that the values of the constants A, B, and C used to calculate the Q/C_{wind} in the EPA's online preliminary remediation goal calculator are significantly different than the values of these constants in Appendix D of USEPA (2002).*

The PEF value in the EPA's calculator could have been matched to the PEF value calculated from IDEQ (2004) by inputting a made-up value, rather than the standard default, for a user-provided input parameter. However, the contribution inhalation of contaminated dust makes to the total radiological dose is much less than the contribution from incidental ingestion of soil, and completely insignificant compared with the contribution due to external exposure to radiation associated with contaminated soil. Because the PEF will not affect the outcome of the BRA for radium-226, the calculator was not artificially manipulated to achieve a desired PEF.

A/T Comment: Response OK

94. Section 4.1.1.2; Page 4-2; Paragraph 2; After Line 11

It appears that not the same constituents were selected as constituents of potential ecological concern (COPEC) in upstream, downstream, and pond surface water. For example, cobalt, copper and thallium were selected in downstream and pond surface water, but not in upstream water (Table A4-3). Antimony was selected in upstream and pond surface water, but not in downstream surface water (Table A4-4). Please include an explanation in Section 4.1.1.2 for not selecting the same list of constituents in all surface water samples tested at the site (Tables A4-3 through A4-5).

Incorporate some text in this section regarding the final 2016 Aquatic Life Ambient Water Quality Criterion for Selenium in Freshwater and the fact that new values are available for lotic and lentic surface waters but that P4 used the draft value of 0.005 mg/L.

P4 Response (SC-94)*: Separate screening tables were created because hardness, and therefore hardness-dependent criteria for some metals, varies between upstream, downstream, and pond surface water sampling locations. The list of analytes is not identical between Tables A4-3 through A4-5 because Screening tables for all media include only detected analytes. The final surface water COPECs listed in Table A4-7 includes all COPECs identified in Tables A4-3 through A4-5. Text in the first paragraph of Section 4.1.1.2 has been revised to clarify this point.*

Regarding the use of the final 2016 Aquatic Life Ambient Water Quality Criterion for Selenium, please note that the text does cite the new selenium criterion for lotic systems However, the criterion was released after the screening had been performed, and because selenium was already a COPEC based on existing criteria, Tables A4-3 through A4-5 were not updated in the draft report. In the revised report, the screening value for lentic systems has been added to the final paragraph of Section 4.1.1.2, and the new criteria for lotic and lentic systems have been added to Tables A4-3 and A4-4 (lotic criterion) and A4-5 (lentic criterion).

A/T Comment: Response OK

95. Section 4.2, Page 4-3, last paragraph, Sentence 1

Suggest removing the word "process" from this sentence so it reads more clearly.

P4 Response (SC-95)*: The word "process" has been replaced by "ERA."*

A/T Comment: Response OK

96. Section 4.2.1.1, Page 4-4, Paragraph 2, Sentence 1

Suggest revising "Disregarding the influence of environmental contaminants …" to read as "Disregarding the influence of environmental contaminants and physical disturbance …"

P4 Response (SC-96)*: Agreed; text has been modified as requested.*

A/T Comment: Response OK

97. Section 4.3.1; Page 4-21; Paragraph "Amphibian and Fish/American Goldfinch"

Although the methodology used to assess the risk of amphibians is appropriate, in the case of fish it would be more appropriate to use fish tissue data when available. It appears that some tissue data has been collected (Table 4-18); if the species of these forage fish (redside shiners, speckled dace) tissue concentrations are available then it would be valuable to incorporate these data in the ERA. Otherwise, an acknowledgement of the lack of this information and how this affects the overall risk assessment should be mentioned in the uncertainty section.

The HQ for the American goldfinch for silver is 0.12, so delete silver from the list of COPCs exceeding an HQ of 1.

P4 Response (SC-97)*: Fish tissue data have been added in a table embedded in text and evaluated qualitatively.*

Silver has been deleted from the list of COPECs exceeding an HQ of 1 for the American goldfinch.

A/T Comment: Response OK

98. Section 4.3.2; Page 4-24; Paragraph 3; Lines 2-5

Modify the text to read similar to: "Excess hazard associated with antimony in the Henry Mine upland soil was also calculated for deer mouse and mink; however, similar to the long-tailed vole, hazards associated with antimony in upland soil for these two constituents was greater at background location than at site."

> ***P4 Response (SC-98)****: Please clarify if the intent of this revision is to add the mink to this paragraph. This change has not made, as the mink is a riparian receptor and is not exposed to upland soil. However, as noted in the response to SC-61, which requested that the presentation of risk results in Section 6.6.2 of the RI be receptor-specific, comparisons between hazards for Site and background media and conclusions regarding risk drivers have been moved to a new Section 4.3.3 of Appendix A. Similarly, text comparing hazards for Site and background media have been moved from receptor-specific results in Section 6.6.2 of the RI to Section 6.9.4 of the RI.*
>
> **A/T Comment:** Yes, the intent of the comment was to include the mink to this paragraph. Agreed the mink is a riparian receptor. Thus, no changes needed.
>
> ***P4 Supplemental Response:*** *Comment noted.*

99. Section 4.3.2; Page 4-25; Paragraph 2; Lines 2-5

Modify the text to read similar to: "Excess hazard associated with antimony in the Henry Mine upland soil was also calculated for long-tailed vole and mink; however, similar to deer mouse, hazards associated with antimony in upland soil for these two constituents was greater at background location than at site."

> ***P4 Response (SC-99)****: Please refer to the response to SC-98.*
>
> **A/T Comment:** Please refer to A/T comment to response for SC-98.

100. Section 4.3.2; Page 4-25; Last Paragraph

Change the range to 0.013 to 3.8 or revise the LOAEL-based value for thallium in Table A4-25.

> ***P4 Response (SC-100)****: The hazard for thallium was inadvertently reported as 0.031 in text, and has been revised to 0.013.*
>
> **A/T Comment:** Response OK

101. Section 5.1; Page 5-1; Paragraph 4; Last Sentence

The document cites Table 7-4 of the Conda/Woodall Mountain Mine RI/FS Site-Specific Livestock Risk Assessment Problem Formulation (Formation Environmental, 2013). This citation is accurate; however, it would be more appropriate to cite the 2016 Final Livestock Risk Assessment Report Conda/Woodall Mountain Mine. Table 4-4 of this document has toxicity reference values for Evaluation of Drinking Water Ingestion by Livestock – Other Chemicals of Interest. Please cite this final document.

> ***P4 Response (SC-101)****: Agreed. The updated reference has been cited in the revised report.*
>
> **A/T Comment:** Response OK

102. Section 5.2.1.1; Page 5-3; Paragraph "Livestock grazing"

It would be helpful to provide additional details in this section (for example, grazing allotment areas [if any], acreage of each allotment area, any restrictions in any of these grazing areas resulting from elevated selenium concentrations, and a map with the location of these grazing areas within the Henry Mine Site).

***P4 Response (SC-102)**: The LRA is a conservative hypothetical evaluation that utilizes Site-wide EPCs to evaluate potential risks to future livestock grazing anywhere on-Site; risks to livestock were not evaluated based on current or potential future grazing allotments. Therefore, this information is not applicable to Appendix A of the RI. However, the requested information will be described in Section 2.0 of the revised RI Report and the future Henry Site Feasibility Study (FS), as it relates to evaluation of remedial measures including best management practices (BMPs) and/or institutional controls (ICs).*

A/T Comment: Response OK

103. Section 5.2.1.2; Page 5-4; Paragraph "Terrestrial environment;" Last Line

This citation is partially accurate. "…adverse toxicity effects from toxicity adverse effects from toxicity may be reversed if the adverse effects did not include developmental deformities" could not be found in USDOI, 1998. Cite appropriate document or delete this portion of the text.

***P4 Response (SC-103)**: The second paragraph on page 143 of the referenced document (USDOI, 1998) states: "Selenium accumulates in and disperses from animal tissues fairly rapidly. Significant changes in tissue selenium status can occur within days, weeks, or months depending on the response criterion of interest and the target tissue being monitored (Wilber 1980; Bennett et al. 1986; USFWS 1990a; Heinz et al. 1990; Heinz and Fitzgerald 1993a; Heinz 1993). Furthermore, the overt symptoms of even near-fatal selenium poisoning in adult birds and mammals can be reversed quickly if the source of selenium exposure is eliminated (Ruta and Haider 1989; Heinz and Fitzgerald 1993b). By contrast, embryonic deformities caused by selenium poisoning are not reversible (Lemly 1993b), nor are some types of tissue damage in adult animals (Sorensen 1991)." No changes to the text were necessary.*

A/T Response: Based on the cited document (USDOI, 1998) rephrase the text similar to: "adverse toxicity effects in adult birds and mammals can be reversed if the source of selenium exposure is eliminated. On the contrary embryonic deformities due to selenium poisoning are not reversible." As it is written, the text suggests that adverse effects from toxicity from selenium maybe reversed only if the effects did not include developmental deformities; however, the key point is that selenium toxicity can be reversed if only exposure to selenium is eliminated.

***P4 Supplemental Response:** The referenced text was revised as indicated.*

104. Table A3-1

- Change the nomenclature of the analyte Radium-226 to Radium-226+D in the analyte column and in note "d". The PRG value for Ra-226+D (radium+ daughter products) using the EPA's PRG calculator as a default for soil is 0.0063 picoCuries per gram (pCi/g); however the value for Ra-226 is 1.15E-02 pCi/g.
- The notes indicate: "All the concentrations in mg/kg except for radium-226, which is in picoCuries per kilogram (pCi/g)." There is an inconsistency in the units in the text and what is shown in parenthesis. Please change the text to picoCuries per gram.
- Note "b" has a typo.

***P4 Response (SC-104):** The analyte column lists constituents as they are identified in the analytical results, rather than as the form for which screening values are available/selected. Footnote d has been corrected to indicate that radium-226 was screened against the PRG for Radium-226+D, rather than radium-226. Additionally, the "*picoCuries per kilogram" *typo in the first note has been* *corrected to read "*picoCuries per gram" *and the "ths" typo in footnote b has been corrected to read "this."*

A/T Comment: Response OK

105. Table A3-3

Note 3 needs to indicate that the RSL Resident Tapwater for carcinogens corresponds to a cancer risk of one in 1 million (TR=1E-06), and for noncarcinogens the HQ is equivalent to 1. Please provide the rationale for using an HQ of 1 for surface water instead of the HQ of 0.1 used in upland soil and sediments (Tables A3-1 and Table A3-4). This information should also be included in Section 3.1.1 (Surface Water) of Appendix A.

P4 Response (SC-105): *Note 3 has been revised to indicate that the RSL Resident Tapwater for carcinogens corresponds to a cancer risk of one in 1 million (TR=1E-06), and for noncarcinogens the HQ is equivalent to 1. The use of RSLs based on an HQ of 1 is consistent with the RI/FS Work Plan and with the Ballard Site BRA. The use of RSLs based on a target HQ of 1 is also consistent with the HQ basis of other surface water screening criteria in Table A3-3, including State of Idaho Surface Water Quality for Domestic Water Supply Use (IAC, 2009) and National Recommended Water Quality Criteria (USEPA, 2015).*

A/T Comment: Response OK

106. Table A3-3

This surface water screening inappropriately uses dissolved concentrations. The standards for protection of human health (DEQ's domestic use, and EPA's MCLs and PRGs) are based on total metals concentrations. The surface water screening tables should be revised to include total concentrations similar to that presented for groundwater.

P4 Response (SC-106): *Please note that the surface water sampling program for the P4 Sites measures dissolved concentrations for all COPCs, except selenium, as described in the 2009/2010 Surface Water Sampling and Analysis Plan (MWH, 2009). In addition, background levels were developed for dissolved concentrations of all COPCs in surface water, with the exception of selenium, as described in the 2013 Background Levels Tech Memo (MWH, 2013). As a result, the available surface water data for all metals and metalloids are expressed as dissolved concentrations.*

A/T Comment: Comments 106, 108, and 114 all describe the same issue where dissolved metals concentrations were compared with DEQ's domestic use, EPA's MCLs, and EPA's PRGs that are based on total metals concentrations. The response indicates that total metals data are unavailable with the exception of selenium. This likely results in an underestimation of risk to humans and certainly for wildlife potentially ingesting surface water at the site since they would not be filtering the water they drink. There does not appear to be any discussion on this non-conservative assumption within the risk characterization and uncertainties discussion. Text needs to be added describing how the exposure to these receptors may be understated.

***P4 Supplemental Response**: A discussion of uncertainty associated with modeling exposure to filtered water samples was added to Section 6.2.*

107. Table A3-5

Footnote "f" (indicating that these constituents were eliminated from further consideration as a result of their low toxicity and being essential nutrients) is unnecessary since none of measured concentrations exceed screening levels, which is a better indicator of the protectiveness.

P4 Response (SC-107): *The only essential nutrient with an available screening criterion is iron. Although iron does not exceed this screening level, footnote "f" has been retained for all essential nutrients because low concentrations and essential nutrient status are equal indicators of protectiveness. According to the COPC selection methodology used in the Henry BRA, constituents without screening levels are retained for quantitative risk evaluation. In this case, were it not for the "essential nutrient status" calcium, magnesium, potassium, and sodium would have been retained as COPCs.*

A/T Comment: Response OK

108. Table A3-6

Again, footnote "a," which indicates surface water COPCs are all in the dissolved form except for selenium, is not correct. Total concentrations should be used for screening versus human health standards.

P4 Response (SC-108): *Please refer to the response to SC-106, above.*

A/T Comment: Please refer to A/T comment to response for SC-106.

P4 Supplemental Response: *See supplemental response for SC-106.*

109. Table A3-13

The two occurrences of "surface water stations" should be changed to "sediment stations" since this is the sediment summary statistics table.

P4 Response (SC-109): *Table A3-13 has been modified as indicated.*

A/T Comment: Response OK

110. Table A3-30

Note "a" indicates that risk estimates for all COPCs are presented in Attachment C. Attachment C presents Tier I background and Human Health Risk Calculations, not Tier II calculations. Please change this reference to Attachment D.

P4 Response (SC-110): *The reference has been changed to Attachment D.*

A/T Comment: Response OK

111. Table A4-1

The column Lowest Soil Screening Level appears to have some inconsistencies. For example, the constituents arsenic, manganese, nickel, and silver are not the lowest concentrations from all of the screening values provided. Make appropriate changes or provide rationale for the selection of the lowest soil screening level in the table's notes and in Section 4.1.1.1 of Appendix A.

P4 Response (SC-111): *The noted inconsistencies have been corrected in the revised BRA. Please note that this correction did not affect the ecological screening results.*

A/T Comment: Response OK

112. Table A4-2

The column "Lowest Soil Screening Level" appears to have some inconsistencies. For example, nickel and silver are not the lowest concentrations from all the screening values provided. Make appropriate changes or provide rationale for the selection of the lowest soil screening level in the table's notes and in Section 4.1.1.1 of Appendix A.

P4 Response (SC-112): *The noted inconsistencies have been corrected in the revised BRA. Please note that this correction did not affect the ecological screening results.*

A/T Comment: Response OK

113. Table A4-3

Revise the hardness value used for the State of Idaho Standards Aquatic Life to 400 mg/L in note "a" to be consistent with statements in Section 4.1.1.2. Provide the reason(s) why cobalt was not included in the list of analytes in Table A4-3. This is inconsistent with the information presented in Table A4-7 (that is, cobalt is a constituent of potential concern in surface water).

P4 Response (SC-113): *The hardness typo in footnote "a" has been corrected as noted. Cobalt is not included in COPEC screening for upstream surface water in Table A4-3 because it was not detected (refer to table A2-5). However, cobalt is listed as a COPEC for the Henry Site in Table A4-7 because it was selected as a COPEC in downstream surface water.*

A/T Comment: Response OK

114. Table A4-3

The EPA water quality criteria for aluminum, iron, and selenium are based on total concentrations. This table and any others using dissolved concentrations for aluminum and iron should be revised to include total concentrations for comparisons to these criteria.

P4 Response (SC-114): *Please refer to response to SC-106.*

A/T Comment: Please refer to A/T comment to response for SC-106.

P4 Supplemental Response: *See supplemental response for SC-106.*

115. Table A4-4

Revise the hardness value used for the State of Idaho Standards Aquatic Life to 256 mg/L in note "a" to be consistent with statements in Section 4.1.1.2.

P4 Response (SC-115): *The hardness typo in footnote "a" has been corrected as noted.*

A/T Comment: Response OK

116. Table A4-15

Section 4.2.1.1 indicates that plant tissue concentrations were based on measured concentrations, when available, instead of modeled concentrations. Add a footnote to this table that describes the modeled approach as being used only when sufficient data were unavailable for using measured tissue concentrations.

P4 Response (SC-116): *The approach for calculating plant tissue doses is clearly described in text and in applicable tables (e.g., Table A4-22, Table F-1, etc). However, a note indicating that modeled plant tissue concentrations were calculated only when measured plant tissue data were insufficient has been added to the BAF table (A4-15).*

A/T Comment: Response OK

117. Table A4-21

Please provide the rationale for evaluating surface water data as one exposure unit. Although aggregating data for surface water and sediment over the entire site to calculate a 95% UCL of the mean may be appropriate for exposure to upper trophic level wildlife, it is not appropriate for exposure to fish and amphibian populations that are likely to be exposed within individual streams or ponds. The risk to aquatic resources (where present) using ponds and streams need to be evaluated independently.

P4 Response (SC-117): *Please refer to the response to SC-69.*

A/T Comment: Response OK

118. Table 6-15 and Table A4-7

Note "b" - It would also be good to point out that the maximum manganese detected in soils at the Henry Mine Site (2,580 milligrams per kilogram [mg/kg]) is below the background level identified in MHW (2015) document (3,460 mg/kg) here and the text of the document.

P4 Response (SC-118): *Because the BRA includes calculation of hazard based on background concentrations, background is not used in the screening process. No revisions to the report are necessary.*

A/T Comment: Response OK

119. Table B-27

The chemical-specific HQ for selenium (1.2E-01/5.0E-03) is 24, not 23. Please make appropriate changes in this table and throughout the document.

P4 Response (SC-119): *Please note that although numbers shown in tables are rounded, the full value was carried through the calculation, from EPC to hazard estimate. The dose in Table B-27 is actually 0.115 mg/kg-d, corresponding to a HQ of 23. No revisions to the report are necessary.*

A/T Comment: Add text to the paragraph after Equation 27 in section 3.3.4, page 3-26 to clarify that although values for modeled or measured ingestion doses shown in tables in Attachments B and J are rounded to two significant figures (i.e., one decimal place) HQ calculations were made using modeled or measured ingestion doses rounded to four significant figures (i.e., three decimal places).

P4 Supplemental Response: *Text in Section 3.3.4 was clarified as requested. Please note that calculations are performed in Microsoft Excel and use the full unrounded value available in that program.*

120. Table B-30

The chemical-specific HQ for thallium (1.3E-03/1.0E-05) is 130, not 128. Please make appropriate changes in this table and throughout the document.

P4 Response (SC-120): *Please note that although numbers in tables are rounded, the full value is carried through the calculation, from EPC to hazard estimate. The dose in Table B-30 is actually 0.00128 mg/kg-d, corresponding to a HQ of 128. No revisions to the report are necessary.*

A/T Comment: Please refer to A/T comment to response for SC-119.

P4 Supplemental Response: *See supplemental response for SC-119.*

121. Table B-42

The chemical-specific HQ for selenium (2.3E-01/5.0E-03) is 46, not 45. Please make appropriate changes in this table and throughout the document.

P4 Response (SC-121): *Please note that although numbers shown in tables are rounded, the full value was carried through calculation, from EPC to hazard estimate. The dose in Table B-42 is 0.225 mg/kg-d, corresponding to a HQ of 45. No revisions to the report are necessary.*

A/T Comment: Please refer to A/T comment to response for SC-119.

P4 Supplemental Response: *See supplemental response for SC-119.*

122. Table J-1

The ecological hazard for selenium (1.2/1.4E-01) is 8.6, not 8.2. Please make appropriate changes in this table and throughout the document.

P4 Response (SC-122): *Please note that although numbers shown in tables are rounded, the full value was carried through calculation, from EPC to hazard estimate. The dose in Table J-1 is 1.17 mg/kg-d, and the TRV is 0.143 mg/kg-d, corresponding to a HQ of 8.2. No revisions to the report are necessary.*

A/T Comment: Please refer to A/T comment to response for SC-119.

P4 Supplemental Response: *See supplemental response for SC-119.*

Appendix C – Photographic Log

123. Appendix C; Page 1 of 6; Photo Location MST052

The sign in the photo indicates that this is site MST051. Reconcile.

P4 Response (SC-123): *This photo has been removed from the revised report as the photo for MST051 is located on Page 11 of the appendix.*

A/T Comment: Response OK

Editorial Comments Table

Henry Mine

Editorial Comments

Item No.	Section; Table; Figure	Page	Paragraph	Line (if not obvious)	Agency/Tribe Comments	Did P4 Respond to Comment
	ES.4	ES-3	4 “Riparian Soil”	2	Delete second “investigations” as it is redundant.	
	ES.4	ES-3	3	Sentence 1	Insert “the” to read “… summary of the principal findings for the RI program …”	
	ES.4.1	ES-4	2	10	Delete “reclaimed” as it is redundant.	
	List of Drawings	ix	Drawing 5-2		There is no reference to this drawing in the text. Revise accordingly.	
	Acronyms and Abbreviations	xi			“ILCRs” is not in alphabetical order. Correct.	
	1.0	1-1	1	8	Insert “and” to read “… and the Shoshone-Bannock Tribes (Tribes).”	
	1.2.2.	1-4	Footnote	2	Delete “numeric” as it is redundant.	
	1.2.3	1-6	1 (partial)	4	Change to “Engineering Evaluation /Cost Analysis (EE/CA).”	
	1.2.3	1-6	2 (last)	1	Insert “into” to read “… entered into a new …”	
	2.3.2	2-5	5 (last)	1	Insert a comma to read “(i.e., MDS016).”	
	2.4	2-7	3 (last)	2	Insert a period to read “Oberlindacher, et al. (1982)” for consistency.	
	2.5.2	2-10	1 “Grasses”	1	Insert a space to read “*Bromus inermis*.”	
	2.6.2	2-13	3 (last)	3	Insert “road” to read “… P4 Enoch Valley haul road traverses …”	
	2.6.2.2	2-14	3 (last)	3	Insert “how” to read “… and ultimately how wells and …”	
	2.6.2.2	2-16	1	4	Insert “is” to read “… which is at a depth …”	
	2.6.2.2	2-16	1	Sentence 4	Change to read “The temperature data appear to respond to seasonal fluctuations …”	
	2.6.2.2	2-16	2 (last)	3	Insert a comma to read “… Enoch Valley Mine, is …”	

Henry Mine

Editorial Comments

Item No.	Section; Table; Figure	Page	Paragraph	Line (if not obvious)	Agency/Tribe Comments	Did P4 Respond to Comment
	2.6.2.2	2-20	1 (partial)	4	Replace "and as" with "which" to read "… producing a "noisy" hydrograph, which is typical …"	
	2-7	2-21	1	3	Insert "in" to read "… discussed in the *Area-Wide Assessment* …"	
	2.10.1	2-24	3	2	Change to "Table 2-7."	
	2.10.2	2-27	2	3	Change "freshwater criteria" to "surface water criterion."	
	3.5	3-7	4	7	Change "Section 3.6.3" to "Section 4.6.3."	
	4.3	4-15	2	6	Change "was" to "were" for subject-verb agreement to be consistent with the rest of the document where data is treated as plural. Check all instances to make sure this is consistent throughout the report.	
	4.4.1	4-23	3	2	Change "are exceeded" to "exceed" to read "… and often only exceed in one …" for easier reading.	
	4.4.1	4-24	1 (partial)	Sentence 2	Change to "exceeds" and "criterion" to read "… and there is only one sporadic or anomalous result that slightly exceeds the hexavalent chromium screening criterion, chromium is not discussed further.	
	4.4.2	4-26	2	5	Insert "spring" to read "… with spring exceedances of the selenium …"	
	4.4.4.1	4-29	2	6	Change to "criterion" to read the "… the screening criterion for cadmium …" Check the entire document for instances where the singular criterion should be used in lieu of the plural criteria.	
	4.4.4.1	4-30	1	3-4	Change to "criterion" for both occurrences.	
	4.4.4.1	4-31	2	Sentence 2	Delete "at" to read "Dissolved arsenic concentrations range from …"	
	4.4.4.2	4-31	3	Sentence 3	Change to "stations" to read "… for these stations are reported …"	
	4.5	4-34	5 (last)	3	Change "is" to "are" to read "Groundwater samples collected and analyzed from these wells are used …" for subject-verb agreement.	

Henry Mine

Editorial Comments

Item No.	Section; Table; Figure	Page	Paragraph	Line (if not obvious)	Agency/Tribe Comments	Did P4 Respond to Comment
	4.5.2.1	4-41	4 (last)	3	Delete "a" to read "… (SMCLs are used as reference points …"	
	4.5.3	4-51	2	Sentence 2	Add a hyphen to read "… piper diagram – Figure 4-23 – to evaluate …"	
	4.6.1.2	4-56	4	3	Delete the comma after "soil" to read "… or potential species use, soil and vegetation selenium …"	
	5.1.1.1	5-3	2	6	Change "were" to "where" to read "Therefore, the areas where mass wasting …"	
	5.1.2.2	5-4	5 (last)	2	Should it be "Detail A1" as opposed to "Detail A?" Revise accordingly.	
	5.1.2.2	5-5	1 (partial)	2	Change to "Details B2 and B3)."	
	5.1.4	5-7	2	3	Change "affects" to "affect" for subject-verb agreement.	
	5.1.4	5-7	4 (last)	1	Change to "Sections 2.1 and 2.4."	
	5.1.4	5-7	4 (last)	6	Insert "and" to read "…bedding and is either …"	
	5.1.4.3	5-10	2	11	Insert "the" to read "… flow towards the northwest …"	
	5.2	5-13	3	1	Switch the period and quotation mark to read "analyte specific."	
	5.3.3	5-18	3 (last)	2	Change to "Little Blackfoot River."	
	5.3.3	5-16	4	1	Change "affect" to "effect."	
	5.3.3	5-20	3	3	Change to "concentrations."	
	5.3.4	5-20	3	6	Delete "a" to read "…events at MMW010)."	
	5.3.4	5-20	3	8	Add "they" and change to "exceed" to read "… and they rarely exceed background levels."	
	5.3.4.1	5-21	1	4	Insert "a" to read "… is a more significant pathway."	
	5.3.4.1	5-21	3	Sentence 4	Change to "…directed northerly toward the river and then to a more westerly direction …" as it seems to read more smoothly.	

Henry Mine

Editorial Comments

Item No.	Section; Table; Figure	Page	Paragraph	Line (if not obvious)	Agency/Tribe Comments	Did P4 Respond to Comment
	5.3.4.1	5-23	3 (last)	13	Change "verses" to "versus."	
	5.3.4.3	5-26	2	Sentence 1	Change "… flow path that experiences reducing conditions …"	
	7.2.5	7-7	2	9	Change to "COC" to read "… as a preliminary COC for direct …"	
	7.2.6	7-8	5 (last)	1	Change "not affects" to "no effects."	
	7.2.8	7-11	2	5	Insert a semicolon to read "… noncancer criterion"	
	7.2.9	7-13	3	11 (last)	This reader is not sure what is meant be "detected Site." Revise.	
	7.3	7-14	4	1	Change to "These ecological risk estimates …"	
	Note 4	2-1			Change "of" to "for" to read "… accounts for the topography."	
	Note Orange shaded	4-9		2	Change "levels" to "level" to read "Selenium action level is …" for subject-verb agreement.	
	Drawing 2-3				Reference somewhere that Drawing 2-2 shows the location of Cross Section B-B'.	
	Drawing 5-2				Reference somewhere that Drawing 2-2 shows the location of Cross Section P-P'.	
	Drawing 5-3				Reference somewhere that Drawing 2-2 shows the location of Cross Section N-N'.	

P4 Response (editorial comments): *These comments have been addressed in the revised report.* **A/T Comment:** Response OK

References

Ruby, M. V. and Y. W. Lowney (2012). "Selective soil particle adherence to hands: implications for understanding oral exposure to soil contaminants." Environ Sci Technol **46**(23): 12759-12771. http://www.ncbi.nlm.nih.gov/pubmed/23148503

Stalcup, D. (2016). Recommendations for Sieving Soil and Dust Samples at Lead Sites for Assessment of Incidental Ingestion. Washington, DC, Office of Land and Emergency Management**:** p. 34. https://semspub.epa.gov/work/HQ/100000133.pdf

APPENDIX D-5

A/T Comments to P4 Responses to A/T Additional Comments (dated May 19, 2017) on *P4's Henry Mine Remedial Investigation Report, Draft Rev 0, August 2016*

Submitted to P4 on July 12, 2017

From: Tomten, Dave <Tomten.Dave@epa.gov>
Sent: Wednesday, July 12, 2017 2:53 PM
To: Barry Myers (bmyers@blm.gov); Bruce Narloch; Bruce Olenick; Cary Foulk (cfoulk@integrated-geosolutions.com); Celeste Christensen; Colleen O'Hara-Epperly (cohara@blm.gov); COOPER, RANDALL LEE [AG/1000]; Tomten, Dave; Dennis Smith (dennis.smith2@ch2m.com); Emily Yeager; Gary Billman; Jeff Cundick; Jeff Schut; Jeremy Moore (jeremy_n_moore@fws.gov); Wallace, Joe; Kelly Wright; Leah Wolf Martin (leah@wolfmartininc.com); LEATHERMAN, CHRIS R [AG/1850]; Michael Rowe; Norka Paden (Norka.Paden@deq.idaho.gov); PRICKETT, MOLLY [AG/1850]; Randy Vranes; Sandi Fisher; Shannon Leigh Ansley (sansley@sbtribes.com); Shephard, Burt; Stifelman, Marc; Stumbo, Sherri A -FS; (b) (6) ; Trina Burgin; Vance Drain
Cc: Maley, Timothy
Subject: Henry Mine RI Report

Molly –
This follows up on discussions on the Henry Mine RI Report during our bi-weekly conference call on Monday. During that call, I indicated that the A/T was having additional discussions regarding the groundwater characterization results presented in the RI and the uncertainty associated with characterization of this medium. The principle hydrogeologists that advised the A/T on these matters (Tim, Gerry, and Lorraine) have all since retired. As we have new members joining our team and replacing this hydro expertise, I want to pause and discuss with the A/T the groundwater characterization and uncertainty. To facilitate this discussion, it would be very useful to have a revised draft RI report (in track changes) that includes changes made in response to earlier comments and the usual appendix that includes earlier comments and responses. Therefore, I am requesting that you submit a revised draft RI (in track changes) at this time. If the team identifies any outstanding concerns or potential data gaps, we will advise you and schedule a follow-up discussion with your team.

In addition, we are providing several additional comments on the most recent response to comments that you submitted. If you have questions, we can discuss these during our next bi-weekly call.

1. Section 2.5.2, Page 2-10, last bullet: Please reference the current Shoshone-Bannock list of Culturally Significant Plants provided in the 2016 draft risk scenario document and cross-check against CSPs identified during the CSP survey conducted at Henry, and note any differences.
2. Section 2.9; Page 2-23; Paragraph 5 (last); Sentence 4: Below is additional information about treaty history with the Shoshone and Bannock Tribes. This is provided for background. No changes necessary.
    a. Treaty With The Eastern Shoshoni, 1863
    b. Treaty With The Shoshoni—Northwestern Bands, 1863
    c. Treaty With The Western Shoshoni, 1863
    d. 1867 Presidential Executive Order established Fort Hall Reservation
    e. July 3, 1868 Treaty signed with the Eastern Band Shoshoni and Bannock. Ratified Feb. 26, 1869, and Proclaimed Feb. 24, 1869.
3. Section 2.10.1; Page 2-24; Paragraph 3; Line 4: Please add a sentence providing additional clarification, as requested, to avoid any unintended implications.
4. Section 3.5; Page 3-4: One of our reviewers noted a potential data gap in surface water sampling locations along the Little Blackfoot River, between MST044 to the confluence with Long Valley Creek/Long Valley Creek Tributary. Although no changes are needed in the RI report, the A/T would like to further discuss this potential data gap in the coming weeks, as part of discussions regarding changes to the long-term monitoring plan.

5. Section 4.2.6; Page 4-14; Paragraph 1: Response is unclear. Please clarify, perhaps by summarizing the available data on CSPs.
6. Section 3.3.1.2; Page 3-6; Paragraph 3: Consumption rates for wild game for Native American traditional and subsistence use raise technical and policy issues for the Henry Mine and other mine sites in SE Idaho. In 2016, the Tribes issued a draft report with recommendations for consumption rates for use in risk assessment. These draft recommendations represent a pre-contact Treaty Rights (unlimited) scenario that may not be consistent with CERCLA RME approaches for present, or future conditions. Therefore, please disclose and discuss associated uncertainty in the risk estimates that were developed for the tribal use scenario. Moving forward, we intend to address these tribal consumption rate issues prior to developing risk estimates for the Enoch project. At Enoch, these draft recommendations may be relevant because a significant amount (roughly 40%) of the land is federally managed. In comparison, federally managed land at the Henry site comprised only a small portion of the site (in the range of 5 to 10%).
7. Add the following reference: Stalcup, D. (2016). Considering a Noncancer Oral Reference Dose for Uranium for Superfund Human Health Risk Assessments. Washington, DC, Office of Land and Emergency Management**:** p. 6, plus attachment. https://semspub.epa.gov/work/HQ/196808.pdf

Please call if you have any questions.
Dave

____

Dave Tomten
EPA Region 10
950 W. Bannock Street
Suite 900
Boise, Idaho 83702

208-378-5763
tomten.dave@epa.gov

APPENDIX D-6

P4's Responses to Additional A/T Comments (dated July 12, 2017) on *P4's Henry Mine Remedial Investigation Report, Draft Rev 0, August 2016*

(Third set of P4 responses. Responses to A/T additional comments.)

Submitted to A/T on July 27, 2017

P4's Additional Responses to A/T comments (sent in an email dated 7/12/17)

on the

***Draft Henry RI/BRA Report* (and RTCs prepared for earlier A/T comments)**

Supplemental A/T comments sent via Dave Tomten email:

1. Section 2.5.2, Page 2-10, last bullet: Please reference the current Shoshone-Bannock list of Culturally Significant Plants provided in the 2016 draft risk scenario document and cross-check against CSPs identified during the CSP survey conducted at Henry, and note any differences.

P4 Response (#1): *A footnote has been included in Section 2.5.2 to reference the Shoshone-Bannock list of culturally significant plants provided in the February 2016 Exposure Scenario for Use in Risk Assessment. The footnote generally notes the difference between the 2009 and 2016 plant lists.*

2. Section 2.9; Page 2-23; Paragraph 5 (last); Sentence 4: Below is additional information about treaty history with the Shoshone and Bannock Tribes. This is provided for background. No changes necessary.
    a. Treaty With The Eastern Shoshoni, 1863
    b. Treaty With The Shoshoni—Northwestern Bands, 1863
    c. Treaty With The Western Shoshoni, 1863
    d. 1867 Presidential Executive Order established Fort Hall Reservation
    e. July 3, 1868 Treaty signed with the Eastern Band Shoshoni and Bannock. Ratified Feb. 26, 1869, and Proclaimed Feb. 24, 1869.

P4 Response (#2): *Comment noted.*

3. Section 2.10.1; Page 2-24; Paragraph 3; Line 4: Please add a sentence providing additional clarification, as requested, to avoid any unintended implications.

P4 Response (#3): *A sentence has been added as requested. The text highlighted in red below has been inserted in Section 2.10.1.*

"The primary known/recognized source material of contaminants associated with phosphate mining in SE Idaho is the Meade Peak Member of the Phosphoria Formation (see Table 2-7 for a stratigraphic column). In particular, the waste shale between ore horizons contributes much of the constituent loading. This is in part because the middle or center waste shale (CWS), as it is known, represents a significant portion of the overburden that is stockpiled when the ore is removed, and this shale is enriched with COPCs/COPECs, most notably selenium, but also other elements like cadmium and uranium. Please note that in undisturbed and pre-mined areas, these same enriched constituents contribute to elevated background concentrations of these COPCs/COPECs in soils overlying the Meade Peak Member. However, because of local pedogenetic and geochemical conditions, the actual constituents that are elevated and their concentrations may vary spatially in these soils (i.e., more or less enriched depending on location). In addition, naturally elevated background concentrations in the soils overlying the Meade Peak can result in elevated concentrations of some elements in soil downslope of Meade Peak outcrops and it is hypothesized that concentrations may be elevated in stream sediment, and possibly downgradient groundwater and surface water (MWH, 2015b). Thinner waste shale beds above and below the ore horizons also contain elevated concentrations of the Site constituents. Figure 2-10 depicts

the relevant portion of stratigraphic section associated with mining activities in SE Idaho along with the average phosphorus content of the ore horizons."

4. Section 3.5; Page 3-4: One of our reviewers noted a potential data gap in surface water sampling locations along the Little Blackfoot River, between MST044 to the confluence with Long Valley Creek/Long Valley Creek Tributary. Although no changes are needed in the RI report, the A/T would like to further discuss this potential data gap in the coming weeks, as part of discussions regarding changes to the long-term monitoring plan.

P4 Response (#4): *Comment noted.*

5. Section 4.2.6; Page 4-14; Paragraph 1: Response is unclear. Please clarify, perhaps by summarizing the available data on CSPs.

P4 Response (#5): *The referenced comment, SC-18, and initial P4 response are pasted below:*

> **18. Section 4.2.6; Page 4-14; Paragraph 1**
>
> If it was "not possible to segregate riparian vegetation results by plant species," how were preliminary COC concentrations in culturally significant riparian vegetation measured? Discuss.
>
> ***P4 Response (SC-18)****: As discussed in Section 4.2.6, riparian vegetation was sampled and analyzed for a suite of five constituents of concern (i.e., cadmium, copper, molybdenum, selenium, and zinc). The BRA in Appendix A, Sections 3.3.2.1 and 3.3.2.2 states that measured riparian vegetation data were used in the risk assessment calculations for aquatic culturally significant plants, where available. When plant tissue data were unavailable (i.e., not one the five COCs listed above), the plant tissue concentrations of individual constituents (e.g., vanadium) were modeled based on uptake from soil and sediment.*

As further clarification, no tissue concentration data for CSPs was available for riparian vegetation. Riparian vegetation was sampled in 2004, only, and classification of vegetation samples by plant type was performed during the 2009 sampling effort. Therefore, metals concentrations specific to culturally significant riparian vegetation were not available for the risk assessment calculations. Instead, measured metals concentrations in the entire unclassified riparian plant tissue dataset, where available, were used to model consumption of culturally significant plants for the Native American. Note that, as indicated in Section 3.3.2.1 of Appendix A, where measured concentrations in unclassified riparian plant tissue were not available, plant tissue concentrations were modeled from riparian soil.

For the purpose of the BRA, all measured riparian vegetation concentrations were assumed to be collected from culturally significant riparian vegetation species. This information has been included in Section 4.2.6 of the revised report.

6. Section 3.3.1.2; Page 3-6; Paragraph 3: Consumption rates for wild game for Native American traditional and subsistence use raise technical and policy issues for the Henry Mine and other mine sites in SE Idaho. In 2016, the Tribes issued a draft report with recommendations for consumption rates for use in risk assessment. These draft recommendations represent a pre-contact Treaty Rights (unlimited) scenario that may not be consistent with CERCLA RME approaches for present, or future conditions. Therefore, please disclose and discuss associated uncertainty in the risk estimates that were developed for the tribal use scenario. Moving forward,

we intend to address these tribal consumption rate issues prior to developing risk estimates for the Enoch project. At Enoch, these draft recommendations may be relevant because a significant amount (roughly 40%) of the land is federally managed. In comparison, federally managed land at the Henry site comprised only a small portion of the site (in the range of 5 to 10%).

P4 Response (#6): *We appreciate the opportunity to review and incorporate exposure information described in the Shoshone-Bannock Exposure Scenario for Use in Risk Assessment: Traditional Substance Lifeways (Shoshone-Bannock Tribes, 2016) document, and look forward to working with the Tribes to develop community-specific exposure modeling assumptions for culturally significant plant and game consumption. The ingestion rates for culturally significant plants and elk tissue used in the baseline risk assessment for the Henry Site were developed from the US EPA's Exposure Factor Handbook, but do not include the level of community-specific information summarized in Shoshone-Bannock Tribes (2016). As noted in P4's supplemental response to A/T Comment SC87, the original Native American game consumption rate of 18 grams per day for an adult used in the Draft Henry Mine RI Report was replaced with a higher value of 44.5 grams per day derived from Table 11-6 of the 1997 version of the Exposure Factors Handbook (USEPA, 1997). The following uncertainty text, which has been added to Section 6.8.2 and to the BRA in Appendix A, references cancer risk and noncancer hazard estimates based the above-referenced, revised elk ingestion rates for a child and adult Native American.*

"Ingestion rates for culturally significant plants and elk tissue used in the baseline risk assessment for the Henry Site were developed from the US EPA's Exposure Factor Handbook, but do not include the level of community-specificity information summarized in Shoshone-Bannock Tribes (2016). The RME vegetation ingestion rate of 293 grams per day for an adult is approximately double an ingestion rate of about 150 grams per day estimated from Attachment 1 of Shoshone-Bannock Tribes (2016). Because the Henry Site contains a limited amount of federally managed land where subsistence-level plant and game harvesting can occur, and all consumed vegetation was assumed to be comprised of Henry Site-derived culturally significant plants, the Native American plant consumption risk estimates presented in the Henry Mine RI Report are not believed to be significantly underestimated.

Noncancer hazard estimates for ingestion of elk tissue based on an ingestion rate of 44.5 grams per day for an adult and the maximum detected concentration of metals in soil at the Henry Site range from 0.00000033 to 0.040; the cancer risk estimate for consumption of elk tissue is $7.2x10^{-7}$*. Elk consumption rates estimated from Attachment 2 of Shoshone-Bannock Tribes (2016) range from 169 grams per day to 217 grams per day. Thus, the above supplemental cancer risk and noncancer hazard estimates for elk consumption by a Native American may be underestimated by a factor of about 4 – 5 times. Although the elk ingestion rates for the Native American may underestimate actual elk consumption rates based on the information included in Shoshone-Bannock Tribes (2016), the consumption of elk tissue is a minor contributor to overall risk compared with direct soil contact pathways. Thus while uncertainty in the elk tissue ingestion rate is high, uncertainty associated with the impact of this pathway on the overall conclusions of the baseline risk assessment is low."*

7. Add the following reference: Stalcup, D. (2016). Considering a Noncancer Oral Reference Dose for Uranium for Superfund Human Health Risk Assessments. Washington, DC, Office of Land and Emergency Management**:** p. 6, plus attachment. https://semspub.epa.gov/work/HQ/196808.pdf

P4 Response (#7): *This reference has been included in the BRA in Appendix A.*